

TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829, SINGLE-CHANNEL HIGH-SPEED MOSFET DRIVER

SLVS160C – FEBRUARY 1997 – REVISED OCTOBER 2002

- Low-Cost Single-Channel High-Speed MOSFET Driver
- I_{CC} . . . 15- μ A Max (TPS2828, TPS2829)
- 25-ns Max Rise/Fall Times and 40-ns Max Propagation Delay . . . 1-nF Load
- 2-A Peak Output Current
- 4-V to 14-V Driver Supply Voltage Range; Internal Regulator Extends Range to 40 V (TPS2816, TPS2817, TPS2818, TPS2819)
- 5-pin SOT-23 Package
- -40°C to 125°C Ambient-Temperature Operating Range
- Highly Resistant to Latch-ups

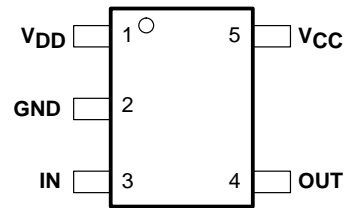
description

The TPS28xx single-channel high-speed MOSFET drivers are capable of delivering peak currents of up to 2 A into highly capacitive loads. High switching speeds (t_r and $t_f = 14$ ns typ) are obtained with the use of BiCMOS outputs. Typical threshold switching voltages are $2/3$ and $1/3$ of V_{CC} . The design inherently minimizes shoot-through current.

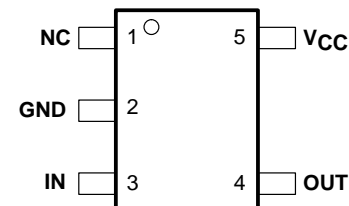
A regulator is provided on TPS2816 through TPS2819 devices to allow operation with supply inputs between 14 V and 40 V. The regulator output can be used to power other circuits, provided power dissipation does not exceed package limitations. If the regulator is not required, V_{DD} (the regulator input) should be connected to V_{CC} . The TPS2816 and TPS2817 input circuits include an active pullup circuit to eliminate the need for an external resistor when using open-collector PWM controllers. The TPS2818 and TPS2819 are identical to the TPS2816 and TPS2817, except that the active pullup circuit is omitted. The TPS2828 and TPS2829 are identical to the TPS2818 and TPS2819, except that the internal voltage regulator is omitted, allowing quiescent current to drop to less than 15 μ A when the inputs are high or low.

The TPS28xx series devices are available in 5-pin SOT-23 (DBV) packages and operate over an ambient temperature range of -40°C to 125°C .

TPS2816, TPS2817
TPS2818, TPS2819
DBV PACKAGE
(TOP VIEW)



TPS2828, TPS2829
DBV PACKAGE
(TOP VIEW)



NC – No internal connection

AVAILABLE OPTIONS

| T _A | FUNCTION | PACKAGED DEVICES | CHIP FORM |
|--|--|------------------|-----------|
| | | SOT-23-5 (DBV) | (Y) |
| -40°C to 125°C | Inverting driver with active pullup input | TPS2816DBV | TPS2816Y |
| | Noninverting driver with active pullup input | TPS2817DBV | TPS2817Y |
| | Inverting driver | TPS2818DBV | TPS2818Y |
| | Noninverting driver | TPS2819DBV | TPS2819Y |
| | Inverting driver, no regulator | TPS2828DBV | TPS2828Y |
| | Noninverting driver, no regulator | TPS2829DBV | TPS2829Y |

The DBV package is available taped and reeled only.



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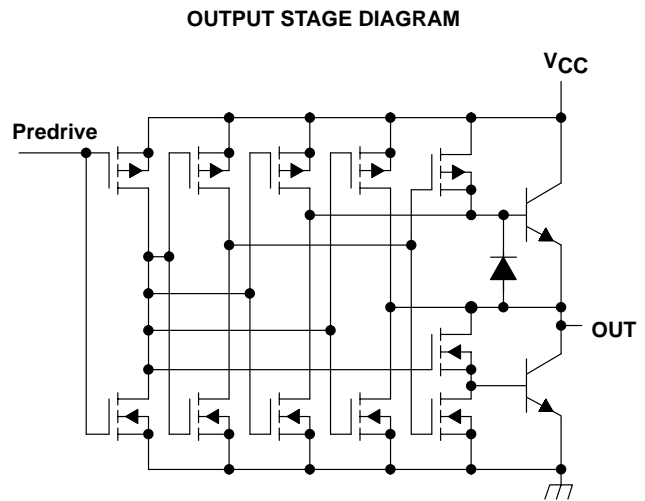
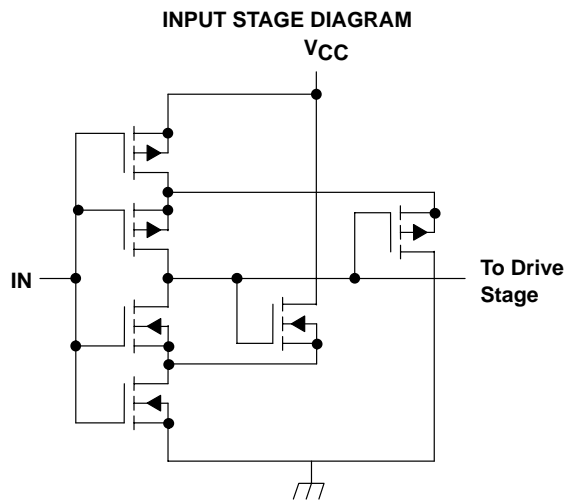
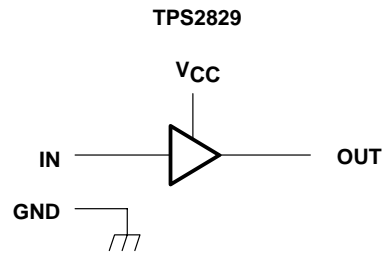
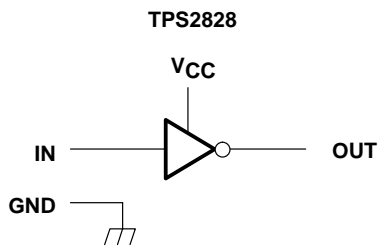
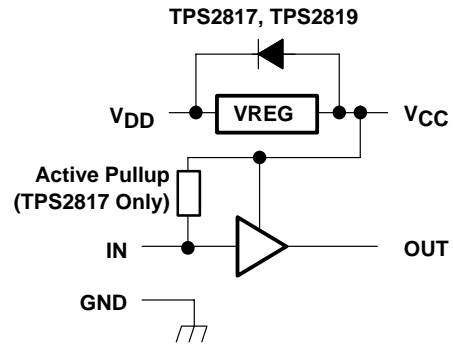
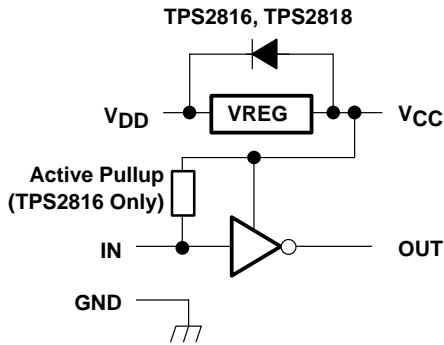
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functional block diagram



TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829, SINGLE-CHANNEL HIGH-SPEED MOSFET DRIVER

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DISSIPATION RATING TABLE

| PACKAGE | T _A ≤ 25°C POWER RATING | DERATING FACTOR ABOVE T _A = 25°C | T _A = 70°C POWER RATING | T _A = 80°C POWER RATING |
|---------|---------------------------------------|--|---------------------------------------|---------------------------------------|
| DBV | 437 mW | 3.5 mW/°C | 280 mW | 227 mW |

These dissipation ratings are based upon EIA specification JESD51-3, "Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages," in tests conducted in a zero-airflow, wind tunnel environment.

absolute maximum ratings over operating temperature range (unless otherwise noted)†

| | |
|---|----------------------------------|
| Supply voltage range, V _{CC} | –0.3 V to 15 V |
| Regulator supply voltage range, V _{DD} | V _{CC} –0.3 V to 42 V |
| Input voltage range, I _N | –0.3 V to V _{CC} +0.5 V |
| Output voltage range, (pin 4) | –0.5 V to V _{CC} +0.5 V |
| Continuous regulator output current, V _{CC} | 25 mA |
| Continuous output current, OUT | ±100 mA |
| Continuous total power dissipation | See Dissipation Rating Table |
| Operating ambient temperature range, T _A | –40°C to 125°C |
| Storage temperature range, T _{stg} | –65°C to 150°C |
| Lead temperature 1,6 mm (1/16inch) from case for 10 seconds | 260°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.

NOTE 1: All voltages are with respect to device GND terminal.

recommended operating conditions

| | MIN | MAX | UNIT |
|--|------|-----------------|------|
| Regulator input voltage range, V _{DD} , TPS2816 through TPS2819 | 8 | 40 | V |
| Supply voltage, V _{CC} | 4 | 14 | V |
| Input voltage, I _N | –0.3 | V _{CC} | V |
| Continuous regulator output current, I _{CC} | 0 | 20 | mA |
| Operating ambient temperature range, T _A | –40 | 125 | °C |

TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829, SINGLE-CHANNEL HIGH-SPEED MOSFET DRIVER

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TPS28xx electrical characteristics over recommended operating ambient temperature range, $V_{CC} = 10\text{ V}$, V_{DD} tied to V_{CC} , $C_L = 1\text{ nF}$ (unless otherwise specified)

Inputs

| PARAMETER | TEST CONDITIONS | MIN | TYP† | MAX | UNIT |
|--|-------------------------|-----|------|-----|---------------|
| Positive-going input threshold voltage | $V_{CC} = 5\text{ V}$ | | 3.3 | 4 | V |
| | $V_{CC} = 10\text{ V}$ | | 6.6 | 7 | |
| | $V_{CC} = 14\text{ V}$ | | 9.3 | 10 | |
| Negative-going input threshold voltage | $V_{CC} = 5\text{ V}$ | 1 | 1.7 | | V |
| | $V_{CC} = 10\text{ V}$ | 2 | 3.3 | | |
| | $V_{CC} = 14\text{ V}$ | 2.5 | 4.6 | | |
| Input voltage hysteresis | | | 1.3 | | V |
| Input current, TPS2818/19/28/29 | Input = 0 V or V_{CC} | | 0.2 | | μA |
| Input current, TPS2816/17 | Input = 0 V | | 650 | | μA |
| | Input = V_{CC} | | 15 | | |
| Input capacitance | | | 5 | 10 | pF |

† Typical values are for $T_A = 25^\circ\text{C}$ unless otherwise noted.

outputs

| PARAMETER | TEST CONDITIONS | MIN | TYP† | MAX | UNIT |
|---------------------------|------------------------|------|------|------|------|
| High-level output voltage | $I_O = -1\text{ mA}$ | 9.75 | 9.9 | | V |
| | $I_O = -100\text{ mA}$ | 8 | 9.1 | | |
| Low-level output voltage | $I_O = 1\text{ mA}$ | | 0.18 | 0.25 | V |
| | $I_O = 100\text{ mA}$ | | 1 | 2 | |

† Typical values are for $T_A = 25^\circ\text{C}$ unless otherwise noted.

regulator, TPS2816 through TPS2819

| PARAMETER | TEST CONDITIONS | MIN | TYP† | MAX | UNIT |
|---------------------------|---|-----|------|-----|------|
| Output voltage | $14 \leq V_{DD} \leq 40\text{ V}$, $0 \leq I_O \leq 20\text{ mA}$ | 10 | 11.5 | 13 | V |
| Output voltage in dropout | $I_O = 10\text{ mA}$, $V_{DD} = 10\text{ V}$ | 8 | | 10 | V |

† Typical values are for $T_A = 25^\circ\text{C}$ unless otherwise noted.

supply current

| PARAMETER | TEST CONDITIONS | MIN | TYP† | MAX | UNIT |
|------------------------------|---------------------|--|------|------|---------------|
| Supply current into V_{CC} | TPS2816, TPS2817 | $I_N = \text{high} = 10\text{ V}$ | 150 | 250 | μA |
| | | $I_N = \text{low} = 0\text{ V}$ | 650 | 1000 | |
| | TPS2818, TPS2819 | $I_N = \text{high or low}$, High = 10 V, Low = 0 V | 25 | 50 | |
| | | | 0.1 | 15 | |
| Supply current into V_{DD} | TPS2816, TPS2817 | $V_{DD} = 20\text{ V}$, $I_N = \text{high} = 10\text{ V}$ or low = 0 V | 650 | 1000 | μA |
| | TPS2818, TPS2819 | $V_{DD} = 20\text{ V}$, $I_N = \text{high} = 10\text{ V}$ or low = 0 V | 50 | 150 | |

† Typical values are for $T_A = 25^\circ\text{C}$ unless otherwise noted.

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TPS28xxY electrical characteristics at $T_A = 25^\circ\text{C}$, $V_{CC} = 10\text{ V}$, V_{DD} tied to V_{CC} , $C_L = 1\text{ nF}$ (unless otherwise specified)

Inputs

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|-------------------------|-----|------|-----|------------------|
| Positive-going input threshold voltage | $V_{CC} = 5\text{ V}$ | | 3.3 | | V |
| | $V_{CC} = 10\text{ V}$ | | 6.6 | | |
| | $V_{CC} = 14\text{ V}$ | | 9.3 | | |
| Negative-going input threshold voltage | $V_{CC} = 5\text{ V}$ | | 1.7 | | V |
| | $V_{CC} = 10\text{ V}$ | | 3.3 | | |
| | $V_{CC} = 14\text{ V}$ | | 4.6 | | |
| Input voltage hysteresis | | | 1.3 | | V |
| Input current, TPS2818/19/28/29 | Input = 0 V or V_{CC} | | 0.2 | | μA |
| Input current, TPS2816/17 | Input = 0 V | | 650 | | μA |
| | Input = V_{CC} | | 15 | | |
| Input resistance | | | 1000 | | $\text{M}\Omega$ |
| Input capacitance | | | 5 | | pF |

outputs

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------------------|------------------------|-----|------|-----|------|
| High-level output voltage | $I_O = -1\text{ mA}$ | | 9.9 | | V |
| | $I_O = -100\text{ mA}$ | | 9.1 | | |
| Low-level output voltage | $I_O = 1\text{ mA}$ | | 0.18 | | V |
| | $I_O = 100\text{ mA}$ | | 1 | | |

regulator, TPS2816 through TPS2819

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---------------------------|---|-----|------|-----|------|
| Output voltage | $14 \leq V_{DD} \leq 40\text{ V}$, $0 \leq I_O \leq 20\text{ mA}$ | | 11.5 | | V |
| Output voltage in dropout | $I_O = 10\text{ mA}$, $V_{DD} = 10\text{ V}$ | | 9 | | V |

supply current

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------------------|---------------------|---|-----|-----|---------------|
| Supply current into V_{CC} | TPS2816, TPS2817 | IN = high = 10 V | | 150 | μA |
| | | IN = low = 0 V | | 650 | |
| | TPS2818, TPS2819 | IN = high or low, High = 10 V, Low = 0 V | | 25 | |
| | | | | 0.1 | |
| Supply current into V_{DD} | TPS2816, TPS2817 | $V_{DD} = 20\text{ V}$, IN = high = 10 V or low = 0 V | | 650 | μA |
| | TPS2818, TPS2819 | $V_{DD} = 20\text{ V}$, IN = high = 10 V or low = 0 V | | 50 | |

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switching characteristics for all devices over recommended operating ambient temperature range, $V_{CC} = 10\text{ V}$, V_{DD} tied to V_{CC} , $C_L = 1\text{ nF}$ (unless otherwise specified)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------|--|------------------------|-----|-----|-----|------|
| t_r | Rise time | $V_{CC} = 14\text{ V}$ | | | 25 | ns |
| | | $V_{CC} = 10\text{ V}$ | | 14 | 30 | |
| | | $V_{CC} = 5\text{ V}$ | | | 35 | |
| t_f | Fall time | $V_{CC} = 14\text{ V}$ | | | 25 | ns |
| | | $V_{CC} = 10\text{ V}$ | | 14 | 30 | |
| | | $V_{CC} = 5\text{ V}$ | | | 35 | |
| t_{PHL} | Propagation delay time, high-to-low-level output | $V_{CC} = 14\text{ V}$ | | | 40 | ns |
| | | $V_{CC} = 10\text{ V}$ | | 24 | 45 | |
| | | $V_{CC} = 5\text{ V}$ | | | 50 | |
| t_{PLH} | Propagation delay time, low-to-high-level output | $V_{CC} = 14\text{ V}$ | | | 40 | ns |
| | | $V_{CC} = 10\text{ V}$ | | 24 | 45 | |
| | | $V_{CC} = 5\text{ V}$ | | | 50 | |

PARAMETER MEASUREMENT INFORMATION

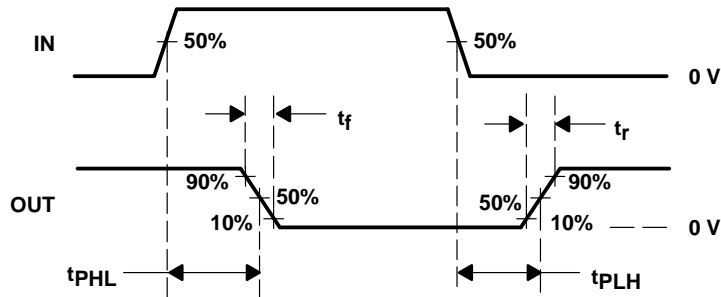


Figure 1. Typical Timing Diagram (TPS2816)

TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829, SINGLE-CHANNEL HIGH-SPEED MOSFET DRIVER

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PARAMETER MEASUREMENT INFORMATION

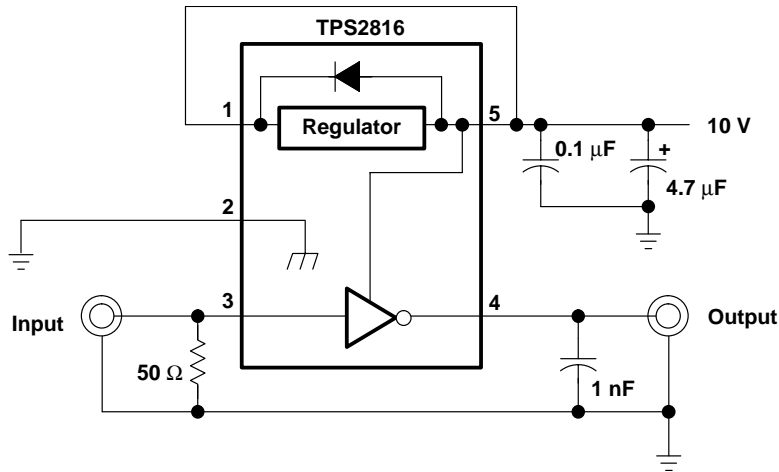


Figure 2. Switching Time Test Setup

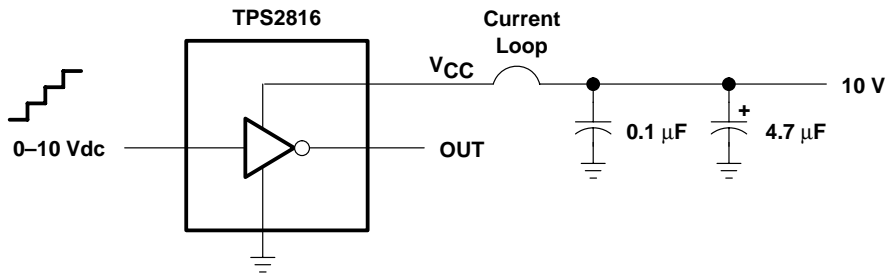


Figure 3. Shoot-Through Current Test Setup

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TYPICAL CHARACTERISTICS

Table of Graphs

| | | FIGURE |
|-----------------------------|-----------------------------|--------|
| Rise time | vs Supply voltage | 4 |
| Fall time | vs Supply voltage | 5 |
| Propagation time (L>H) | vs Supply voltage | 6 |
| Propagation Time (H>L) | vs Supply voltage | 7 |
| Rise time | vs Ambient temperature | 8 |
| Fall time | vs Ambient temperature | 9 |
| Propagation time (L>H) | vs Supply voltage | 10 |
| Propagation time (H>L) | vs Ambient temperature | 11 |
| Supply current (V_{CC}) | vs Supply voltage | 12 |
| Supply current (V_{CC}) | vs Load capacitance | 13 |
| Supply current (V_{CC}) | vs Ambient temperature | 14 |
| Input threshold voltage | vs Supply voltage | 15 |
| Regulator output voltage | vs Regulator supply voltage | 16 |
| Regulator quiescent current | vs Regulator supply voltage | 17 |
| Shoot-through current | vs Input voltage (L>H) | 18 |
| Shoot-through current | vs Input voltage (H>L) | 19 |

TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829, SINGLE-CHANNEL HIGH-SPEED MOSFET DRIVER

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TYPICAL CHARACTERISTICS

RISE TIME
vs
SUPPLY VOLTAGE

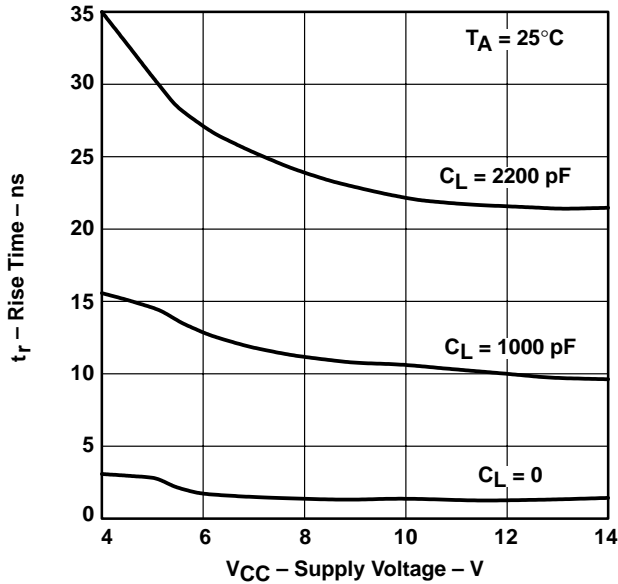


Figure 4

FALL TIME
vs
SUPPLY VOLTAGE

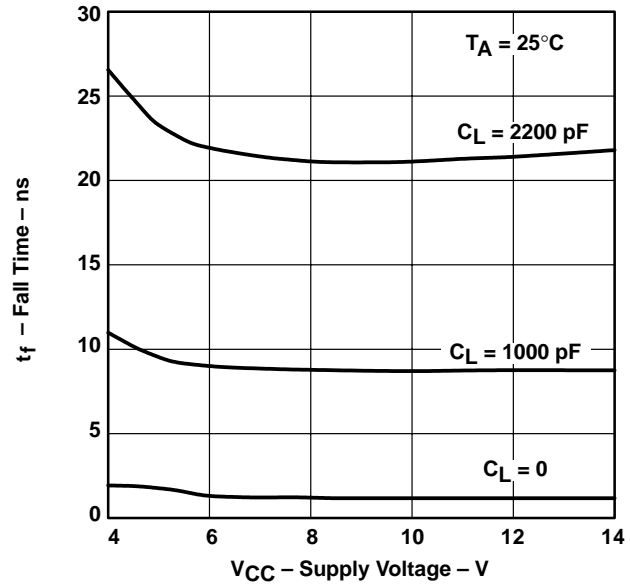


Figure 5

PROPAGATION DELAY TIME,
LOW-TO-HIGH-LEVEL OUTPUT
vs
SUPPLY VOLTAGE

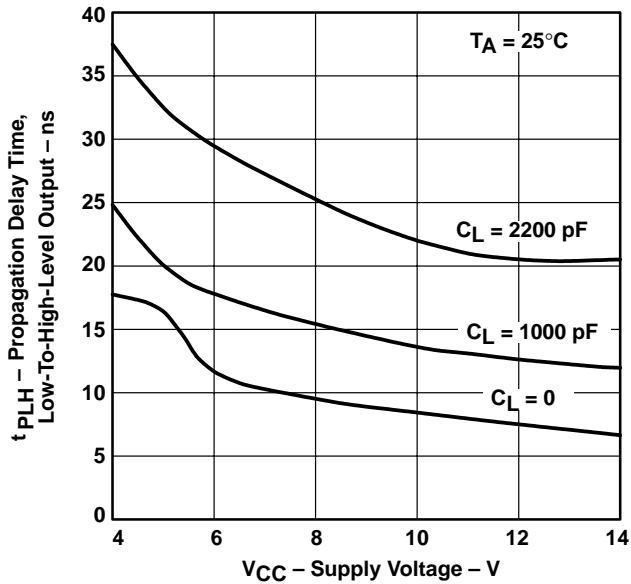


Figure 6

PROPAGATION DELAY TIME,
HIGH-TO-LOW-LEVEL OUTPUT
vs
SUPPLY VOLTAGE

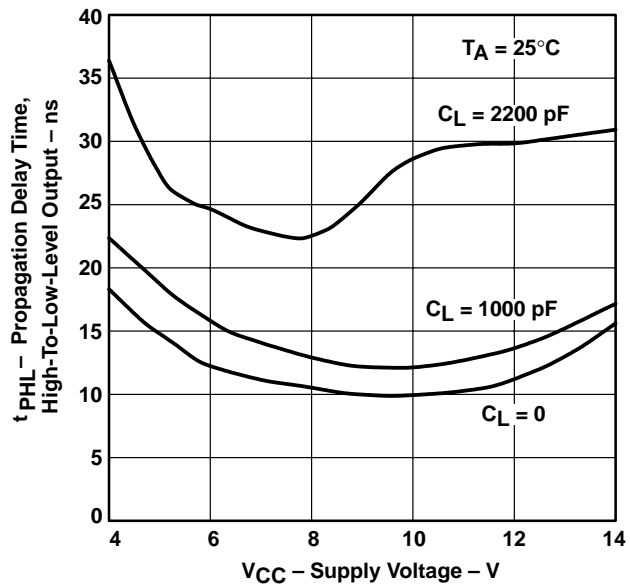


Figure 7

TYPICAL CHARACTERISTICS

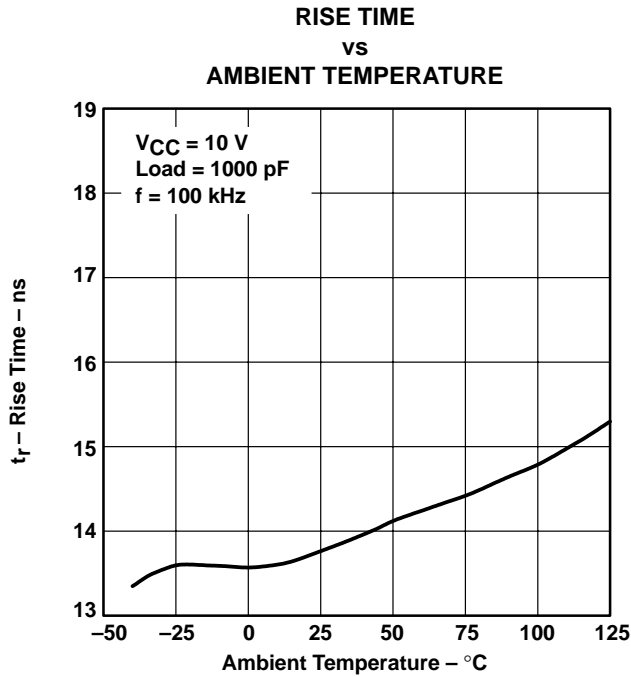


Figure 8

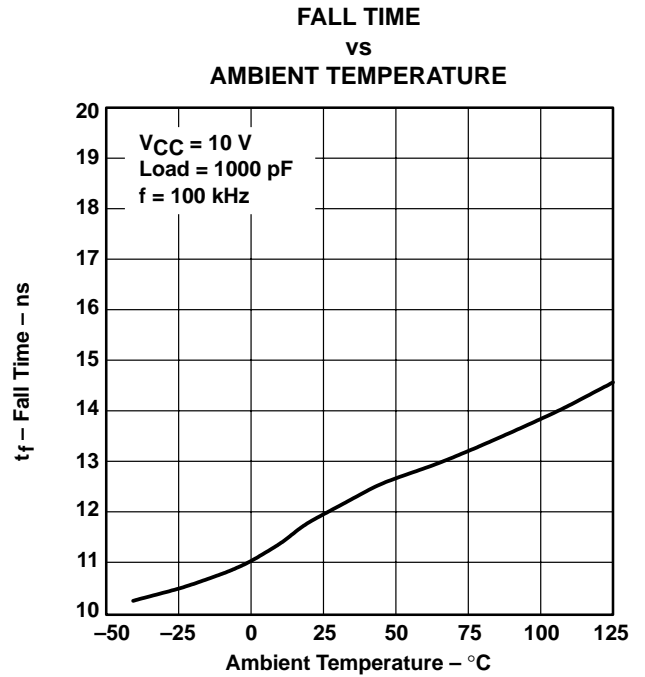


Figure 9

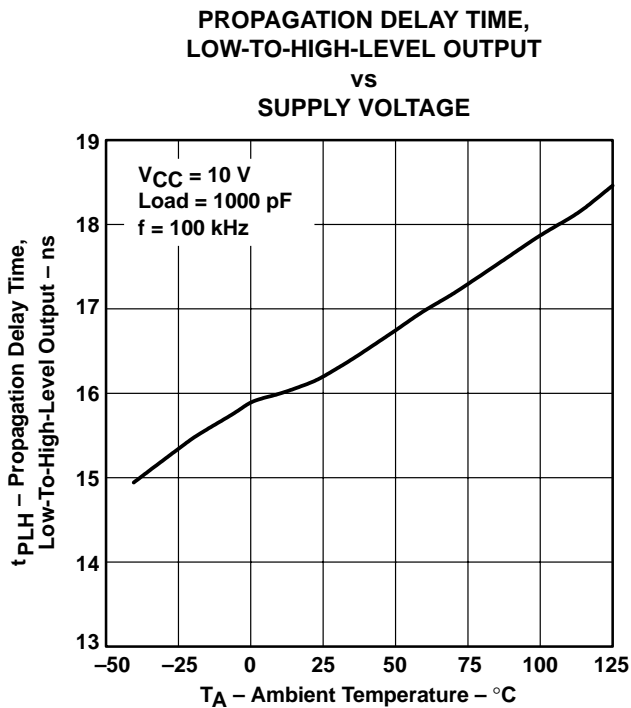


Figure 10

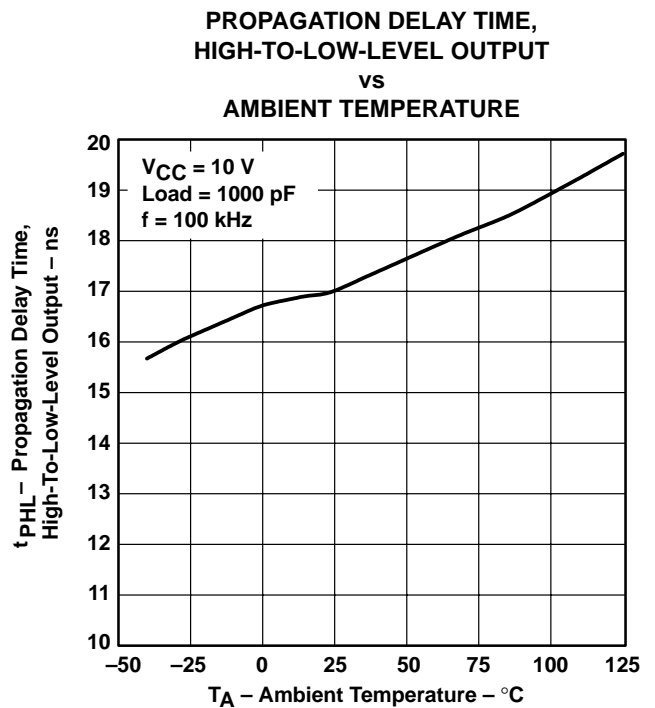


Figure 11

TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829, SINGLE-CHANNEL HIGH-SPEED MOSFET DRIVER

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TYPICAL CHARACTERISTICS

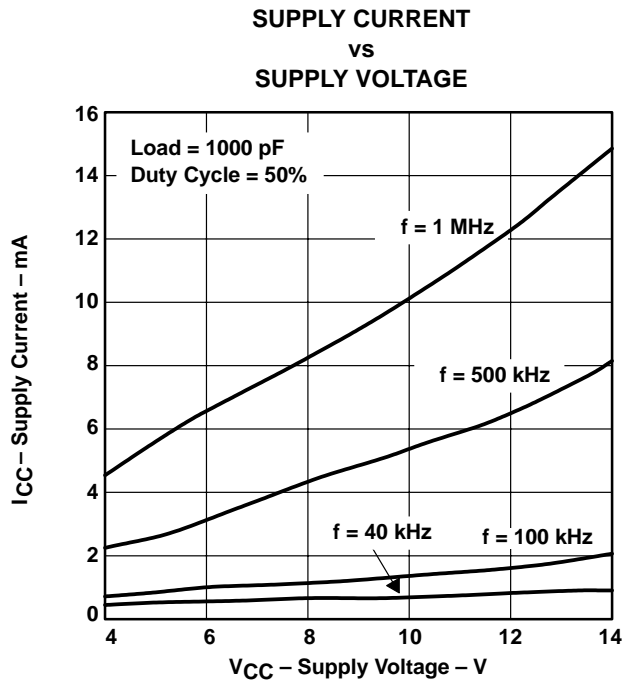


Figure 12

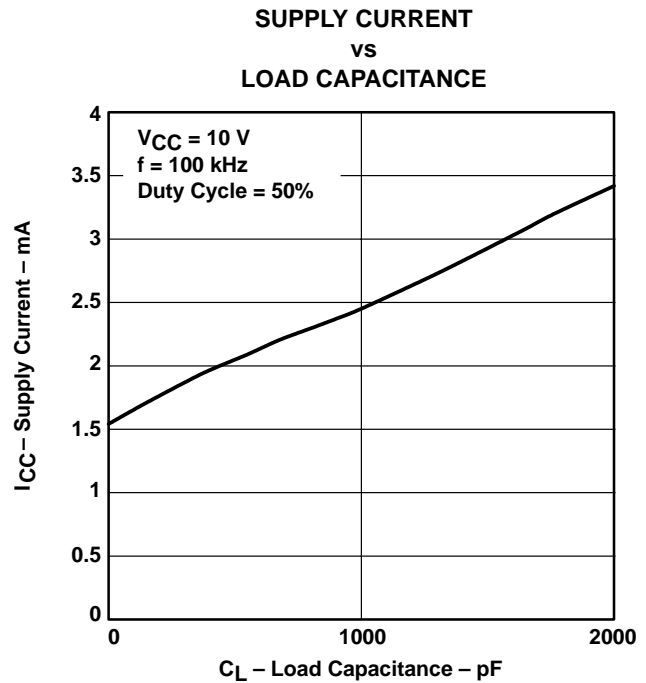


Figure 13

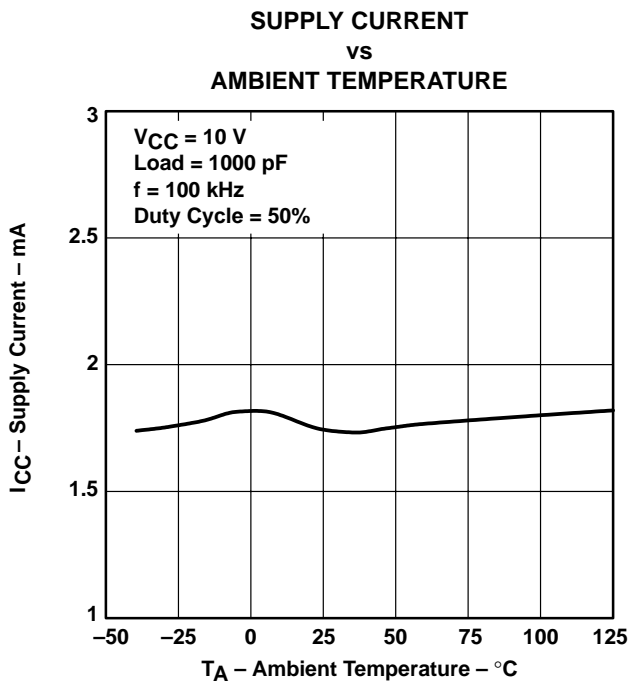


Figure 14

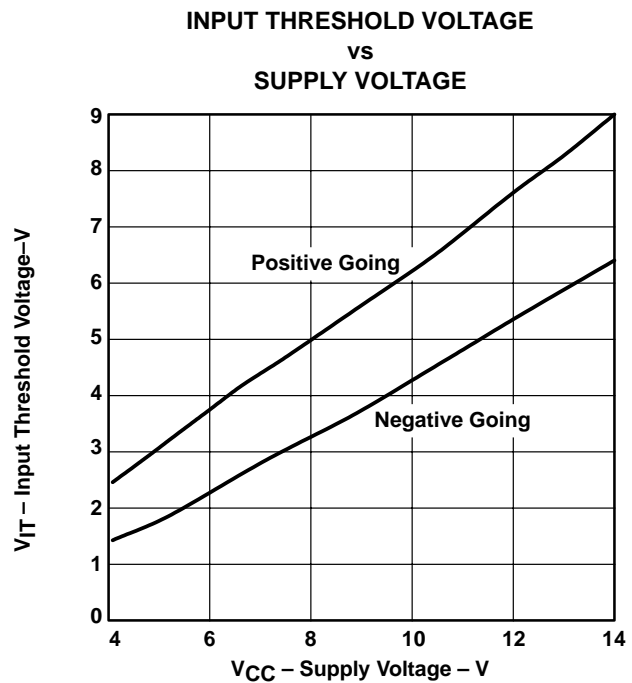


Figure 15

TYPICAL CHARACTERISTICS

REGULATOR OUTPUT VOLTAGE
vs
REGULATOR SUPPLY VOLTAGE

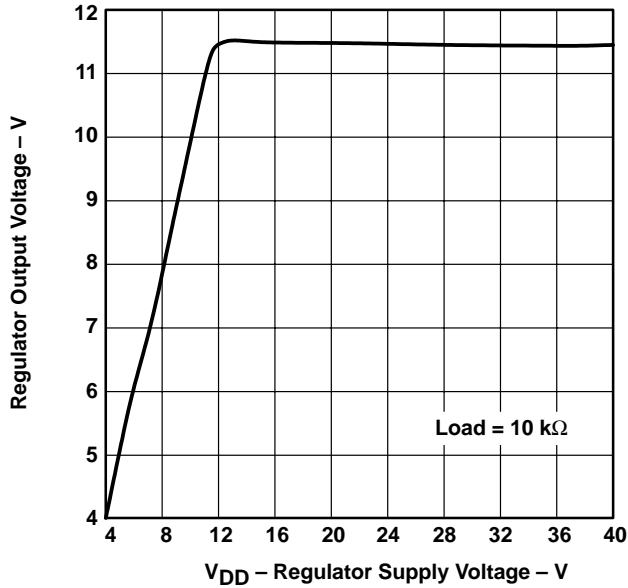


Figure 16

REGULATOR QUIESCENT CURRENT
vs
REGULATOR SUPPLY VOLTAGE

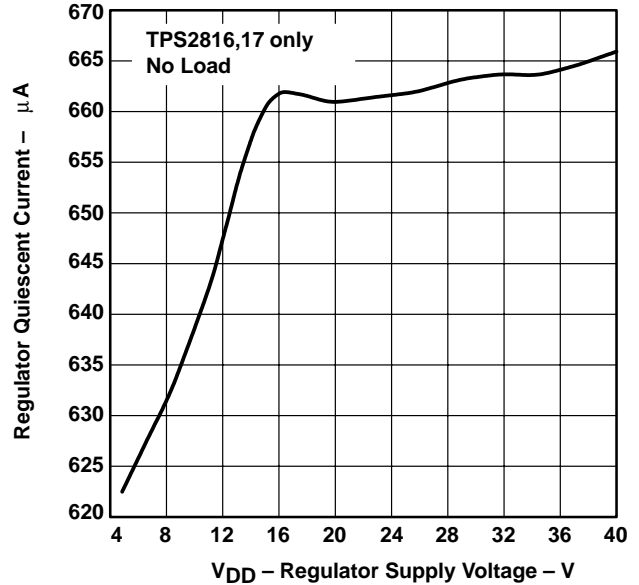


Figure 17

SHOOT-THROUGH CURRENT
vs
INPUT VOLTAGE LOW-TO-HIGH

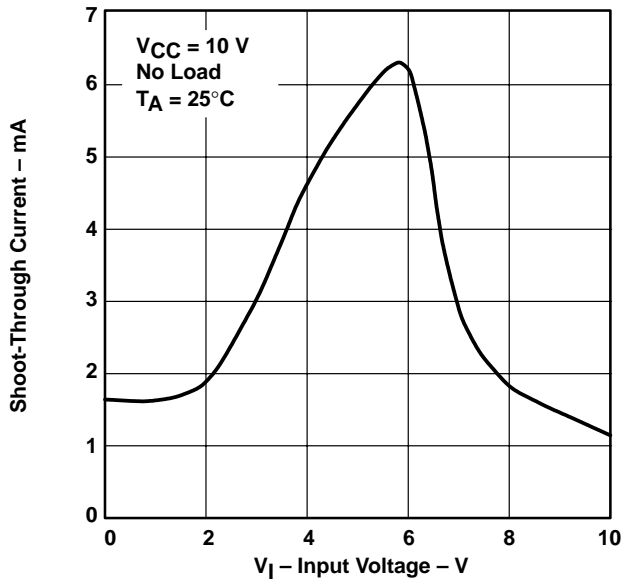


Figure 18

SHOOT-THROUGH CURRENT
vs
INPUT VOLTAGE HIGH-TO-LOW

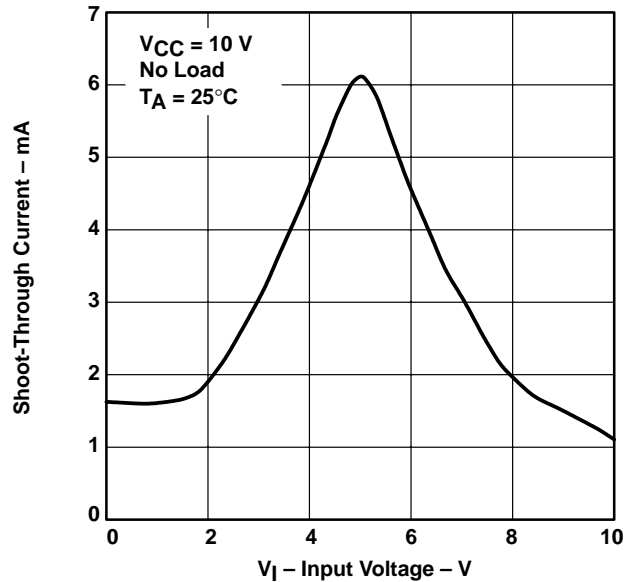


Figure 19

TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829, SINGLE-CHANNEL HIGH-SPEED MOSFET DRIVER

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APPLICATION INFORMATION

MOSFETs are voltage-driven devices that require very little steady-state drive current. However, the large input capacitance (200 pF to 3000 pF or greater) of these devices requires large current surges to reduce the turn-on and turn-off times. The TPS2816 series of high-speed drivers can supply up to 2 A to a MOSFET, greatly reducing the switching times. The fast rise times and fall times and short propagation delays allow for operation in today's high-frequency switching converters.

In addition, MOSFETs have a limited gate-bias voltage range, usually less than 20 V. The TPS2816 series of drivers extends this operating range by incorporating an on-board series regulator with an input range up to 40 V. This regulator can be used to power the drivers, the PWM chip, and other circuitry, providing the power dissipation rating is not exceeded.

When using these devices, care should be exercised in the proper placement of the driver, the switching MOSFET, and the bypass capacitor. Because of the large input capacitance of the MOSFET, the driver should be placed close to the gate to eliminate the possibility of oscillations caused by trace inductance ringing with the gate capacitance of the MOSFET. When the driver output path is longer than approximately 2 inches, a resistor in the range of 10 Ω should be placed in series with the gate drive as close as possible to the MOSFET. A ceramic bypass capacitor is also recommended to provide a source for the high-speed current transients that the MOSFET requires. This capacitor should be placed between V_{CC} and GND of the driver (see Figures 20 and 21).

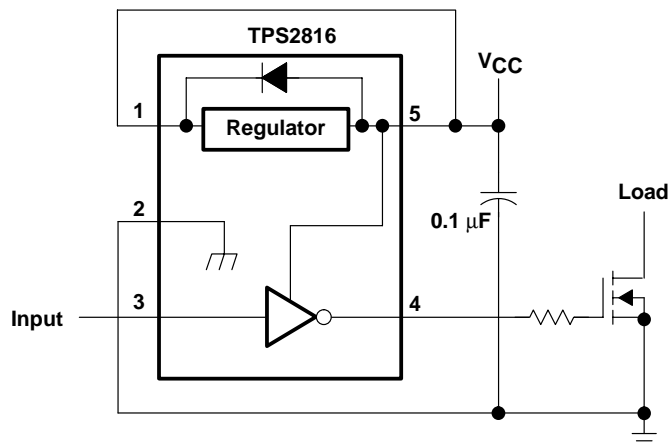


Figure 20. $V_{CC} < 14\text{ V}$

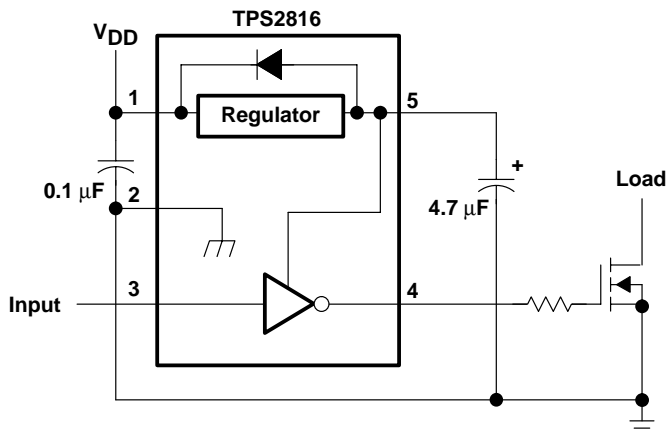


Figure 21. $V_{CC} > 14\text{ V}$

APPLICATION INFORMATION

The on-board series regulator supplies approximately 20 mA of current at 11.5 V, some of which can be used for external circuitry, providing the power dissipation rating for the driver is not exceeded. When using the on-board series regulator, an electrolytic output capacitor of 4.7 μF or larger is recommended. Although not required, a 0.1- μF ceramic capacitor on the input of the regulator can help suppress transient currents (see Figure 22). When not used, the regulator should be connected to V_{CC} . Grounding V_{DD} will result in destruction of the regulator.

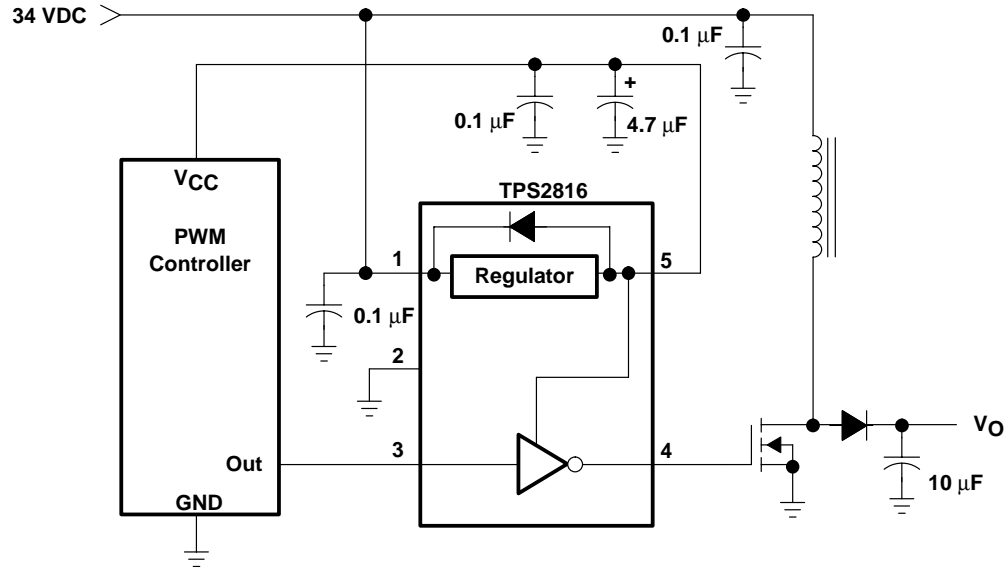


Figure 22. Boost Application

The TPS2816 and TPS2818 drivers include active pullup circuits on the inputs to eliminate the need for external pullup resistors when using controllers with open-collector outputs (such as the TL5001). The TPS2817 and TPS2819 drivers have standard CMOS inputs providing a total device operating current of less than 50 μA . All devices switch at standard CMOS logic levels of approximately $2/3 V_{CC}$ with positive-going input levels, and approximately $1/3 V_{CC}$ with negative-going input levels. Being CMOS drivers, these devices will draw relatively large amounts of current (Approximately 5 mA) when the inputs are in the range of one-half of the supply voltage. In normal operation, the driver input is in this range for a very short time. Care should be taken to avoid use of very low slew-rate inputs, used under normal operating conditions. Although not destructive to the device, slew rates slower than 0.1 V/ μs are not recommended.

The BiCMOS output stage provides high instantaneous drive current to rapidly toggle the power switch, and very low drop to each rail to ensure proper operation at voltage extremes.

Low-voltage circuits (less than 14 V) that require very low quiescent currents can use the TPS2828 and TPS2829 drivers. These drivers use typically 0.2 μA of quiescent current (with inputs high or low). They do not have the internal regulator or the active pullup circuit, but all other specifications are the same as for the rest of the family.

2.5-V/3.3-V, 3-A application

Figure 23 illustrates the use of the TPS2817 with a TL5001 PWM controller and a TPS1110 in a simple step-down converter application. The converter operates at 275 kHz and delivers either 2.5 V or 3.3 V (determined by the value of R_6) at 3 A (5 A peak) from a 5-V supply. The bill of materials is provided in Table 1.

TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829, SINGLE-CHANNEL HIGH-SPEED MOSFET DRIVER

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APPLICATION INFORMATION

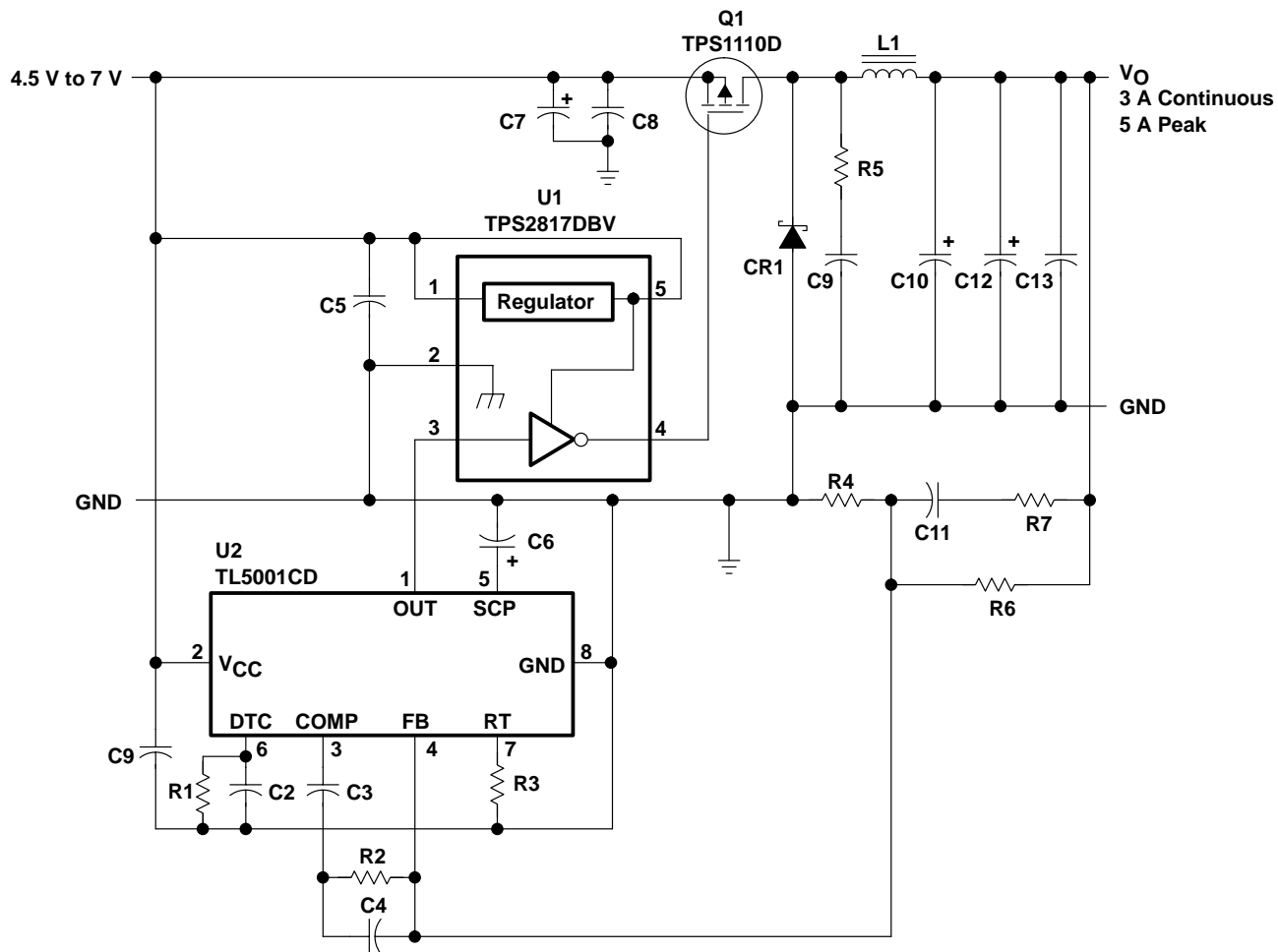


Figure 23. Step-Down Application

NOTE: If the parasitics of the external circuit cause the voltage to violate the Absolute Maximum Rating for the Output pins, Schottky diodes should be added from ground to output and from output to Vcc.

TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829, SINGLE-CHANNEL HIGH-SPEED MOSFET DRIVER

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APPLICATION INFORMATION

Table 1. Bill of Materials

| REF DES | PART NO. | DESCRIPTION | MFR |
|----------------|--------------|--|----------------|
| U1 | TPS2817DBV | IC, MOSFET driver, single noninverting | TI |
| U2 | TL5001CD | IC, PWM controller | TI |
| Q1 | TPS1110D | MOSFET, p-channel, 6 A, 7 V, 75 m Ω | TI |
| C1, C2, C5, C8 | | Capacitor, ceramic, 0.1 μ F, 50 V, X7R, 1206 | |
| C3 | | Capacitor, ceramic, 0.033 μ F, 50 V, X7R, 1206 | |
| C4 | | Capacitor, ceramic, 2200 pF, 50 V, X7R, 0805 | |
| C6 | ECS-T1CY105R | Capacitor, tantalum, 1.0 μ F, 16 V, A case | Panasonic |
| C7 | 10SC47M | Capacitor, OS-Con, 47 μ F, 10 V | Sanyo |
| C9 | | Capacitor, ceramic, 1000 pF, 50 V, X7R, 0805 | |
| C10, C12 | 10SA220M | Capacitor, OS-Con, 220 μ F, 10 V | Sanyo |
| C11 | | Capacitor, ceramic, 0.022 μ F, 50 V, X7R, 0805 | |
| C13 | | Capacitor, ceramic, 47 μ F, 50 V, X7R | |
| CR1 | 50WQ03F | Diode, Schottky, D-pak, 5 A 30 V | IR |
| L1 | SML3723 | Inductor, 27 μ H, +/- 20%, 3 A | Nova Magnetics |
| R1 | | Resistor, CF, 47 k Ω , 1/10 W, 5%, 0805 | |
| R2 | | Resistor, CF, 1.5 k Ω , 1/10 W, 5%, 0805 | |
| R3 | | Resistor, MF, 30.1 k Ω , 1/10 W, 1%, 0805 | |
| R4 | | Resistor, MF, 1.00 k Ω , 1/10 W, 1%, 0805 | |
| R5 | | Resistor, CF, 47 Ω , 1/10 W, 5%, 0805 | |
| R6 (3.3-V) | | Resistor, MF, 2.32 k Ω , 1/10 W, 1%, 0805 | |
| R6 (2.5-V) | | Resistor, MF, 1.50 k Ω , 1/10 W, 1%, 0805 | |
| R7 | | Resistor, CF, 100 Ω , 1/10 W, 5%, 0805 | |

As shown in Figures 24 and 25, the TPS2817 turns on the TPS1110 power switch in less than 20 ns and off in 25 ns.

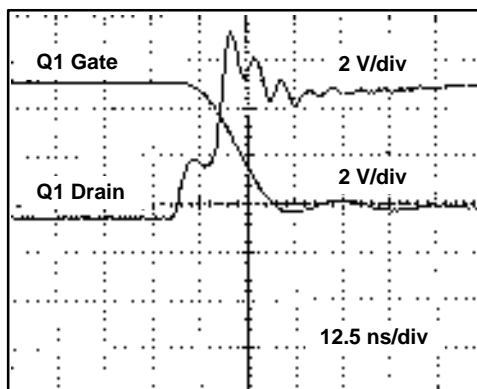


Figure 24. Q1 Turn-On Waveform

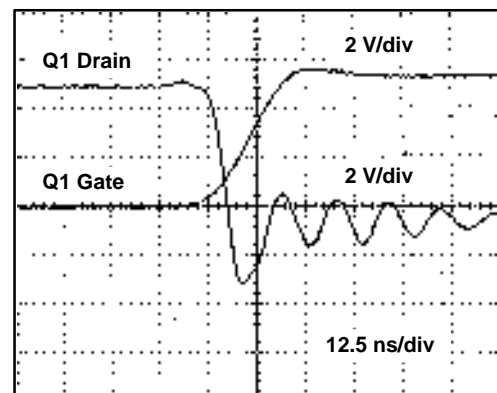


Figure 25. Q1 Turn-Off Waveform

TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829, SINGLE-CHANNEL HIGH-SPEED MOSFET DRIVER

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The efficiency for various output currents, with a 5.25-V input, is shown in Figure 26. For a 3.3-V output, the efficiency is greater than 90% for loads up to 2 A – exceptional for a simple, inexpensive design.

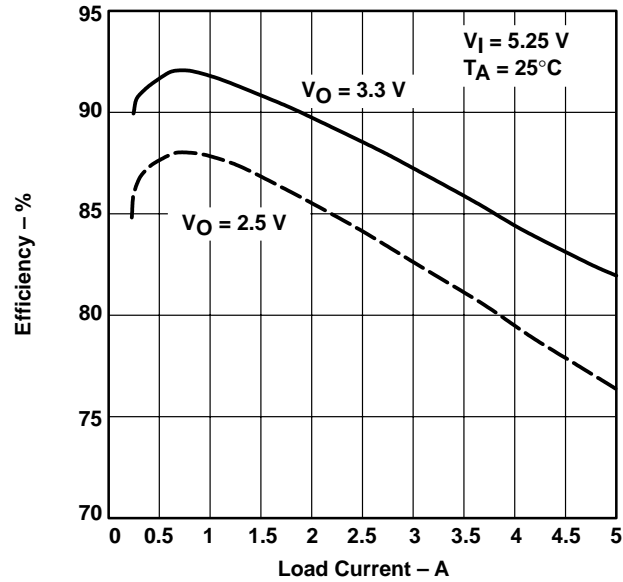


Figure 26. Converter Efficiency

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Top-Side Markings (4) | Samples |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| TPS2816DBV | OBSOLETE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | | | |
| TPS2816DBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PAAI | Samples |
| TPS2816DBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PAAI | Samples |
| TPS2816DBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PAAI | Samples |
| TPS2816DBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PAAI | Samples |
| TPS2817DBV | OBSOLETE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | | | |
| TPS2817DBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PABI | Samples |
| TPS2817DBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PABI | Samples |
| TPS2817DBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PABI | Samples |
| TPS2817DBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PABI | Samples |
| TPS2818DBV | OBSOLETE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | | | |
| TPS2818DBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PACI | Samples |
| TPS2818DBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PACI | Samples |
| TPS2819DBV | OBSOLETE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | | | |
| TPS2819DBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PADI | Samples |
| TPS2819DBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PADI | Samples |
| TPS2819DBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PADI | Samples |
| TPS2819DBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PADI | Samples |
| TPS2828DBV | OBSOLETE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | | | |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Top-Side Markings (4) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| TPS2828DBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PAXI | Samples |
| TPS2828DBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PAXI | Samples |
| TPS2828DBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PAXI | Samples |
| TPS2828DBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PAXI | Samples |
| TPS2829DBV | OBSOLETE | SOT-23 | DBV | 5 | | TBD | Call TI | Call TI | | | |
| TPS2829DBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | PAYI | Samples |
| TPS2829DBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | PAYI | Samples |
| TPS2829DBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | PAYI | Samples |
| TPS2829DBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | PAYI | 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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

(4) Only one of markings shown within the brackets will appear on the physical device.

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OTHER QUALIFIED VERSIONS OF TPS2816, TPS2817, TPS2818, TPS2819, TPS2828, TPS2829 :

- Automotive: [TPS2819-Q1](#), [TPS2829-Q1](#)
- Enhanced Product: [TPS2816-EP](#), [TPS2817-EP](#), [TPS2818-EP](#), [TPS2819-EP](#), [TPS2828-EP](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

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 |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS2816DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 9.0 | 3.15 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TPS2816DBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 9.0 | 3.15 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TPS2817DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 9.0 | 3.15 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TPS2817DBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 9.0 | 3.15 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TPS2818DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 9.0 | 3.15 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TPS2819DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 9.0 | 3.15 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TPS2819DBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 9.0 | 3.15 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TPS2828DBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TPS2828DBVT | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TPS2829DBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| TPS2829DBVT | SOT-23 | DBV | 5 | 250 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS2816DBVR | SOT-23 | DBV | 5 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS2816DBVT | SOT-23 | DBV | 5 | 250 | 182.0 | 182.0 | 20.0 |
| TPS2817DBVR | SOT-23 | DBV | 5 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS2817DBVT | SOT-23 | DBV | 5 | 250 | 182.0 | 182.0 | 20.0 |
| TPS2818DBVR | SOT-23 | DBV | 5 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS2819DBVR | SOT-23 | DBV | 5 | 3000 | 182.0 | 182.0 | 20.0 |
| TPS2819DBVT | SOT-23 | DBV | 5 | 250 | 182.0 | 182.0 | 20.0 |
| TPS2828DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TPS2828DBVR | SOT-23 | DBV | 5 | 3000 | 203.0 | 203.0 | 35.0 |
| TPS2828DBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TPS2829DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TPS2829DBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 180.0 | 18.0 |

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