

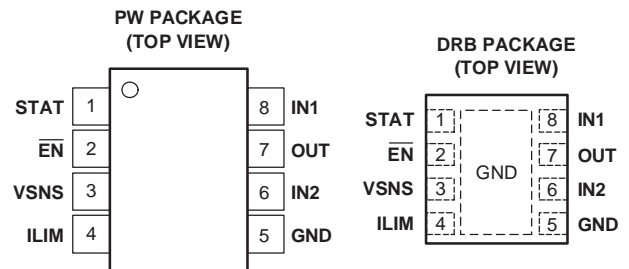
## AUTOSWITCHING POWER MUX

### FEATURES

- Two-Input, One-Output Power Multiplexer With Low  $r_{DS(on)}$  Switches:
  - 84 m $\Omega$  Typ (TPS2113A)
  - 120 m $\Omega$  Typ (TPS2112A)
- Reverse and Cross-Conduction Blocking
- Wide Operating Voltage Range . . . .2.8 V to 5.5 V
- Low Standby Current . . . . 0.5- $\mu$ A Typ
- Low Operating Current . . . . 55- $\mu$ A Typ
- Adjustable Current Limit
- Controlled Output Voltage Transition Times, Limits Inrush Current and Minimizes Output Voltage Hold-Up Capacitance
- CMOS- and TTL-Compatible Control Inputs
- Auto-Switching Operating Mode
- Thermal Shutdown
- Available in TSSOP-8 and 3mm x 3mm SON-8 Packages

### APPLICATIONS

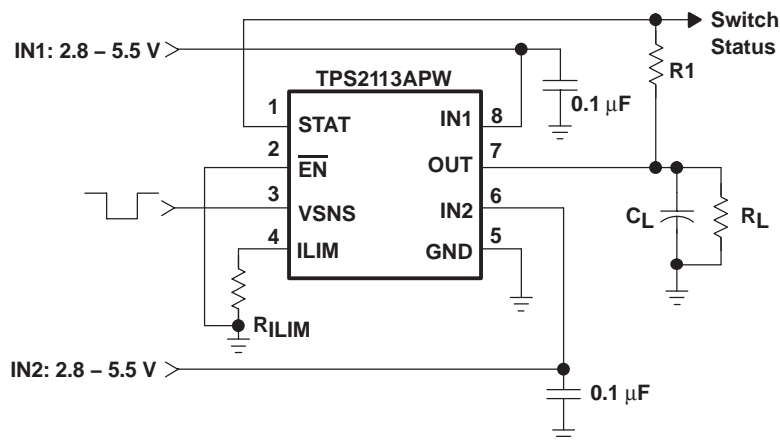
- PCs
- PDAs
- Digital Cameras
- Modems
- Cell Phones
- Digital Radios
- MP3 Players



### DESCRIPTION

The TPS211xA family of power multiplexers enables seamless transition between two power supplies, such as a battery and a wall adapter, each operating at 2.8–5.5 V and delivering up to 1 A. The TPS211xA family includes extensive protection circuitry, including user-programmable current limiting, thermal protection, inrush current control, seamless supply transition, cross-conduction blocking, and reverse-conduction blocking. These features greatly simplify designing power multiplexer applications.

### TYPICAL APPLICATION



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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### AVAILABLE OPTIONS

| FEATURE                        |           | TPS2110A   | TPS2111A   | TPS2112A   | TPS2113A   | TPS2114A   | TPS2115A   |
|--------------------------------|-----------|------------|------------|------------|------------|------------|------------|
| Current Limit Adjustment Range |           | 0.31–0.75A | 0.63–1.25A | 0.31–0.75A | 0.63–1.25A | 0.31–0.75A | 0.63–1.25A |
| Switching Modes                | Manual    | Yes        | Yes        | No         | No         | Yes        | Yes        |
|                                | Automatic | Yes        | Yes        | Yes        | Yes        | Yes        | Yes        |
| Switch Status Output           |           | No         | No         | Yes        | Yes        | Yes        | Yes        |
| Package                        |           | TSSOP-8    | TSSOP-8    | TSSOP-8    | TSSOP-8    | TSSOP-8    | TSSOP-8    |

### ORDERING INFORMATION

| T <sub>A</sub> | PACKAGE      | ORDERING NUMBER(1) | MARKINGS |
|----------------|--------------|--------------------|----------|
| –40°C to 85°C  | TSSOP-8 (PW) | TPS2112APW         | 2112A    |
|                |              | TPS2113APW         | 2113A    |

(1) The PW package is available taped and reeled. Add an **R** suffix to the device type (e.g., TPS2112APWR) to indicate tape and reel.

### PACKAGE DISSIPATION RATINGS

| PACKAGE      | DERATING FACTOR ABOVE<br>T <sub>A</sub> = 25°C | T <sub>A</sub> ≤ 25°C<br>POWER RATING | T <sub>A</sub> = 70°C<br>POWER RATING | T <sub>A</sub> = 85°C<br>POWER RATING |
|--------------|--|---------------------------------------|---------------------------------------|---------------------------------------|
| TSSOP-8 (PW) | 3.9 mW/°C                                      | 387 mW                                | 213 mW                                | 155 mW                                |
| SON-8 (DRB)  | 25.0 mW/°C                                     | 2.50 W                                | 1.38 W                                | 1.0 W                                 |

### ABSOLUTE MAXIMUM RATINGS

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

|  |          | TPS2112A, TPS2113A           |
|--|----------|------------------------------|
| Input voltage range at pins IN1, IN2, $\overline{EN}$ , VSNS, ILIM(2)  |          | –0.3 V to 6 V                |
| Output voltage range, V <sub>O(OUT)</sub> , V <sub>O(STAT)</sub> (2)   |          | –0.3 V to 6 V                |
| Output sink current, I <sub>O(STAT)</sub>                              |          | 5 mA                         |
| Continuous output current, I <sub>O</sub>                              | TPS2112A | 0.9 A                        |
|  | TPS2113A | 1.5 A                        |
| Continuous total power dissipation                                     |          | See Dissipation Rating Table |
| Operating virtual junction temperature range, T <sub>J</sub>           |          | –40°C to 125°C               |
| Storage temperature range, T <sub>stg</sub>                            |          | –65°C to 150°C               |
| Lead temperature soldering 1.6 mm (1/16 inch) from case for 10 seconds |          | 260°C                        |

(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 voltages are with respect to GND.

### RECOMMENDED OPERATING CONDITIONS

|  |                             | MIN  | MAX  | UNIT |
|--|-----------------------------|------|------|------|
| Input voltage at IN1, V <sub>I(IN1)</sub>                | V <sub>I(IN2)</sub> ≥ 2.8 V | 1.5  | 5.5  | V    |
|  | V <sub>I(IN2)</sub> < 2.8 V | 2.8  | 5.5  |      |
| Input voltage at IN2, V <sub>I(IN2)</sub>                | V <sub>I(IN1)</sub> ≥ 2.8 V | 1.5  | 5.5  | V    |
|  | V <sub>I(IN1)</sub> < 2.8 V | 2.8  | 5.5  |      |
| Input voltage, V <sub>I(EN)</sub> , V <sub>I(VSNS)</sub> |                             | 0    | 5.5  | V    |
| Current limit adjustment range, I <sub>O(OUT)</sub>      | TPS2112A                    | 0.31 | 0.75 | A    |
|  | TPS2113A                    | 0.63 | 1.25 |      |
| Operating virtual junction temperature, T <sub>J</sub>   |                             | –40  | 125  | °C   |

## ELECTROSTATIC DISCHARGE (ESD) PROTECTION

|                  | MIN | MAX | UNIT |
|------------------|-----|-----|------|
| Human body model |     | 2   | kV   |
| CDM              |     | 500 | V    |

## ELECTRICAL CHARACTERISTICS

over recommended operating junction temperature range,  $V_{I(IN1)} = V_{I(IN2)} = 5.5\text{ V}$ ,  $R_{LIM} = 400\ \Omega$  (unless otherwise noted)

| PARAMETER   | TEST CONDITIONS                                      | TPS2112A                                 |     |     | TPS2113A |     |            | UNIT |
|---|--|--|-----|-----|----------|-----|------------|------|
|   |  | MIN                                      | TYP | MAX | MIN      | TYP | MAX        |      |
| <b>POWER SWITCH</b>   |  |  |     |     |          |     |            |      |
| $r_{DS(on)}$ <sup>(1)</sup><br>Drain-source on-state resistance (INx-OUT) | $T_J = 25^\circ\text{C}$ ,<br>$I_L = 500\text{ mA}$  | $V_{I(IN1)} = V_{I(IN2)} = 5.0\text{ V}$ | 120 | 140 | 84       | 110 | m $\Omega$ |      |
|   |  | $V_{I(IN1)} = V_{I(IN2)} = 3.3\text{ V}$ | 120 | 140 | 84       | 110 |            |      |
|   |  | $V_{I(IN1)} = V_{I(IN2)} = 2.8\text{ V}$ | 120 | 140 | 84       | 110 |            |      |
|   | $T_J = 125^\circ\text{C}$ ,<br>$I_L = 500\text{ mA}$ | $V_{I(IN1)} = V_{I(IN2)} = 5.0\text{ V}$ |     | 220 |          | 150 | m $\Omega$ |      |
|   |  | $V_{I(IN1)} = V_{I(IN2)} = 3.3\text{ V}$ |     | 220 |          | 150 |            |      |
|   |  | $V_{I(IN1)} = V_{I(IN2)} = 2.8\text{ V}$ |     | 220 |          | 150 |            |      |

(1) The TPS211xA can switch a voltage as low as 1.5 V as long as there is a minimum of 2.8 V at one of the input power pins. In this specific case, the lower supply voltage has no effect on the IN1 and IN2 switch on-resistances.

| PARAMETER   | TEST CONDITIONS   | MIN | TYP  | MAX | UNIT          |
|---|---|-----|------|-----|---------------|
| <b>LOGIC INPUTS (<math>\overline{EN}</math>)</b>            |   |     |      |     |               |
| $V_{IH}$ High-level input voltage                           |   | 2   |      |     | V             |
| $V_{IL}$ Low-level input voltage                            |   |     |      | 0.7 | V             |
| Input current   | $\overline{EN} = \text{High}$ , sink current  |     |      | 1   | $\mu\text{A}$ |
|   | $\overline{EN} = \text{Low}$ , source current   | 0.5 | 1.4  | 5   |               |
| <b>SUPPLY AND LEAKAGE CURRENTS</b>                          |   |     |      |     |               |
| Supply current from IN1 (operating)                         | $V_{I(VSNS)} = 1.5\text{ V}$ , $\overline{EN} = \text{Low}$ (IN1 active), $V_{I(IN1)} = 5.5\text{ V}$ , $V_{I(IN2)} = 3.3\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$ |     | 55   | 90  | $\mu\text{A}$ |
|   | $V_{I(VSNS)} = 1.5\text{ V}$ , $\overline{EN} = \text{Low}$ (IN1 active), $V_{I(IN1)} = 3.3\text{ V}$ , $V_{I(IN2)} = 5.5\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$ |     | 1    | 12  |               |
|   | $V_{I(VSNS)} = 0\text{ V}$ , $\overline{EN} = \text{Low}$ (IN2 active), $V_{I(IN1)} = 5.5\text{ V}$ , $V_{I(IN2)} = 3.3\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$   |     |      | 75  |               |
|   | $V_{I(VSNS)} = 0\text{ V}$ , $\overline{EN} = \text{Low}$ (IN2 active), $V_{I(IN1)} = 3.3\text{ V}$ , $V_{I(IN2)} = 5.5\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$   |     |      | 1   |               |
| Supply current from IN2 (operating)                         | $V_{I(VSNS)} = 1.5\text{ V}$ , $\overline{EN} = \text{Low}$ (IN1 active), $V_{I(IN1)} = 5.5\text{ V}$ , $V_{I(IN2)} = 3.3\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$ |     |      | 1   | $\mu\text{A}$ |
|   | $V_{I(VSNS)} = 1.5\text{ V}$ , $\overline{EN} = \text{Low}$ (IN1 active), $V_{I(IN1)} = 3.3\text{ V}$ , $V_{I(IN2)} = 5.5\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$ |     |      | 75  |               |
|   | $V_{I(VSNS)} = 0\text{ V}$ , $\overline{EN} = \text{Low}$ (IN2 active), $V_{I(IN1)} = 5.5\text{ V}$ , $V_{I(IN2)} = 3.3\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$   |     | 1    | 12  |               |
|   | $V_{I(VSNS)} = 0\text{ V}$ , $\overline{EN} = \text{Low}$ (IN2 active), $V_{I(IN1)} = 3.3\text{ V}$ , $V_{I(IN2)} = 5.5\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$   |     | 55   | 90  |               |
| Quiescent current from IN1 (STANDBY)                        | $\overline{EN} = \text{High}$ (inactive), $V_{I(IN1)} = 5.5\text{ V}$ , $V_{I(IN2)} = 3.3\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$                                 |     | 0.5  | 2   | $\mu\text{A}$ |
|   | $\overline{EN} = \text{High}$ (inactive), $V_{I(IN1)} = 3.3\text{ V}$ , $V_{I(IN2)} = 5.5\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$                                 |     |      | 1   |               |
| Quiescent current from IN2 (STANDBY)                        | $\overline{EN} = \text{High}$ (inactive), $V_{I(IN1)} = 5.5\text{ V}$ , $V_{I(IN2)} = 3.3\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$                                 |     |      | 1   | $\mu\text{A}$ |
|   | $\overline{EN} = \text{High}$ (inactive), $V_{I(IN1)} = 3.3\text{ V}$ , $V_{I(IN2)} = 5.5\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$                                 |     | 0.5  | 2   |               |
| Forward leakage current from IN1 (measured from OUT to GND) | $\overline{EN} = \text{High}$ (inactive), $V_{I(IN1)} = 5.5\text{ V}$ , IN2 open, $V_{O(OUT)} = 0\text{ V}$ (shorted), $T_J = 25^\circ\text{C}$                 |     | 0.1  | 5   | $\mu\text{A}$ |
| Forward leakage current from IN2 (measured from OUT to GND) | $\overline{EN} = \text{High}$ (inactive), $V_{I(IN2)} = 5.5\text{ V}$ , IN1 open, $V_{O(OUT)} = 0\text{ V}$ (shorted), $T_J = 25^\circ\text{C}$                 |     | 0.1  | 5   | $\mu\text{A}$ |
| Reverse leakage current to INx (measured from INx to GND)   | $\overline{EN} = \text{High}$ (inactive), $V_{I(INx)} = 0\text{ V}$ , $V_{O(OUT)} = 5.5\text{ V}$ , $T_J = 25^\circ\text{C}$                                    |     | 0.3  | 5   | $\mu\text{A}$ |
| <b>STAT OUTPUT</b>  |   |     |      |     |               |
| Leakage current   | $V_{O(STAT)} = 5.5\text{ V}$  |     | 0.01 | 1   | $\mu\text{A}$ |
| Saturation voltage  | $I_{I(STAT)} = 2\text{ mA}$ , IN1 switch is on  |     | 0.13 | 0.4 | V             |
| Deglitch time (falling edge only)                           |   |     | 150  |     | $\mu\text{s}$ |

**ELECTRICAL CHARACTERISTICS (Continued)**

over recommended operating junction temperature range,  $V_{I(IN1)} = V_{I(IN2)} = 5.5\text{ V}$ ,  $R_{ILIM} = 400\ \Omega$  (unless otherwise noted)

| PARAMETER                    |  | TEST CONDITIONS   | MIN  | TYP  | MAX  | UNIT          |
|------------------------------|--|---|------|------|------|---------------|
| <b>CURRENT LIMIT CIRCUIT</b> |  |   |      |      |      |               |
| Current limit accuracy       | TPS2112A                                   | $R_{ILIM} = 400\ \Omega$  | 0.51 | 0.63 | 0.80 | A             |
|                              |  | $R_{ILIM} = 700\ \Omega$  | 0.30 | 0.36 | 0.50 |               |
|                              | TPS2113A                                   | $R_{ILIM} = 400\ \Omega$  | 0.95 | 1.25 | 1.56 |               |
|                              |  | $R_{ILIM} = 700\ \Omega$  | 0.47 | 0.71 | 0.99 |               |
| $t_d$                        | Current limit settling time <sup>(1)</sup> | Time for short-circuit output current to settle within 10% of its steady state value. | 1    |      |      | ms            |
| Input current at ILIM        |  | $V_{I(ILIM)} = 0\text{ V}$ , $I_{O(OUT)} = 0\text{ A}$                                | -15  | 0    |      | $\mu\text{A}$ |

(1) Not tested in production.

| PARAMETER   |                          | TEST CONDITIONS                                 | MIN   | TYP   | MAX   | UNIT          |
|---|--------------------------|---|-------|-------|-------|---------------|
| <b>VSNS COMPARATOR</b>  |                          |   |       |       |       |               |
| VSNS threshold voltage  | $V_{I(VSNS)} \uparrow$   |   | 0.78  | 0.8   | 0.82  | V             |
|   | $V_{I(VSNS)} \downarrow$ |   | 0.735 | 0.755 | 0.775 |               |
| VSNS comparator hysteresis <sup>(1)</sup>                               |                          |   | 30    | 60    |       | mV            |
| Deglitch of VSNS comparator (both $\uparrow\downarrow$ ) <sup>(1)</sup> |                          |   | 90    | 150   | 220   | $\mu\text{s}$ |
| Input current   |                          | $0\text{ V} \leq V_{I(VSNS)} \leq 5.5\text{ V}$ | -1    | 1     |       | $\mu\text{A}$ |
| <b>UVLO</b>   |                          |   |       |       |       |               |
| IN1 and IN2 UVLO  | Falling edge             |   | 1.15  | 1.25  |       | V             |
|   | Rising edge              |   | 1.30  |       | 1.35  |               |
| IN1 and IN2 UVLO hysteresis <sup>(1)</sup>                              |                          |   | 30    | 57    | 65    | mV            |
| Internal $V_{DD}$ UVLO (the higher of IN1 and IN2)                      | Falling edge             |   | 2.4   | 2.53  |       | V             |
|   | Rising edge              |   | 2.58  |       | 2.8   |               |
| Internal $V_{DD}$ UVLO hysteresis <sup>(1)</sup>                        |                          |   | 30    | 50    | 75    | mV            |
| UVLO deglitch for IN1, IN2 <sup>(1)</sup>                               |                          | Falling edge                                    | 110   |       |       | $\mu\text{s}$ |

(1) Not tested in production.

| PARAMETER                          |   | TEST CONDITIONS  | MIN | TYP | MAX | UNIT |
|------------------------------------|---|--|-----|-----|-----|------|
| <b>REVERSE CONDUCTION BLOCKING</b> |   |  |     |     |     |      |
| $\Delta V_{O(I\_block)}$           | Minimum output-to-input voltage difference to block switching | $\overline{EN} = \text{high}$ , $V_{I(IN1)} = 3.3\text{ V}$ and $V_{I(IN2)} = V_{I(VSNS)} = 0\text{ V}$ . Connect OUT to a 5 V supply through a series 1-k $\Omega$ resistor. Let $\overline{EN} = \text{low}$ . Slowly decrease the supply voltage until OUT connects to IN1. | 80  | 100 | 120 | mV   |

| PARAMETER  |  | TEST CONDITIONS               | MIN | TYP | MAX | UNIT               |
|--|--|-------------------------------|-----|-----|-----|--------------------|
| <b>THERMAL SHUTDOWN</b>  |  |                               |     |     |     |                    |
| Thermal shutdown threshold <sup>(1)</sup>                                  |  | TPS211xA is in current limit. | 135 |     |     | $^{\circ}\text{C}$ |
| Recovery from thermal shutdown <sup>(1)</sup>                              |  | TPS211xA is in current limit. | 125 |     |     |                    |
| Hysteresis <sup>(1)</sup>  |  |                               | 10  |     |     |                    |
| <b>IN2-IN1 COMPARATORS</b>   |  |                               |     |     |     |                    |
| Hysteresis of IN2-IN1 comparator   |  |                               | 0.1 | 0.2 |     | V                  |
| Deglitch of IN2-IN1 comparator (both $\uparrow\downarrow$ ) <sup>(1)</sup> |  |                               | 10  | 20  | 50  | $\mu\text{s}$      |

(1) Not tested in production.

## SWITCHING CHARACTERISTICS

over recommended operating junction temperature range,  $V_I(IN1) = V_I(IN2) = 5.5\text{ V}$ ,  $R_{ILIM} = 400\ \Omega$  (unless otherwise noted)

| PARAMETER           | TEST CONDITIONS                              | TPS2112A  |   |      | TPS2113A |     |     | UNIT |     |               |    |
|---------------------|--|---|---|------|----------|-----|-----|------|-----|---------------|----|
|                     |  | MIN   | TYP   | MAX  | MIN      | TYP | MAX |      |     |               |    |
| <b>POWER SWITCH</b> |  |   |   |      |          |     |     |      |     |               |    |
| $t_r$               | Output rise time from an enable(1)           | $V_I(IN1) = V_I(IN2) = 5\text{ V}$ ,<br>$V_I(VSNS) = 1.5\text{ V}$  | $T_J = 25^\circ\text{C}$ , $C_L = 1\ \mu\text{F}$ ,<br>$I_L = 500\text{ mA}$ ,<br>See Figure 1(a)   | 0.5  | 1.0      | 1.5 | 1   | 1.8  | 3   | ms            |    |
| $t_f$               | Output fall time from a disable(1)           | $V_I(IN1) = V_I(IN2) = 5\text{ V}$ ,<br>$V_I(VSNS) = 1.5\text{ V}$  | $T_J = 25^\circ\text{C}$ , $C_L = 1\ \mu\text{F}$ ,<br>$I_L = 500\text{ mA}$ ,<br>See Figure 1(a)   | 0.35 | 0.5      | 0.7 | 0.5 | 1    | 2   | ms            |    |
| $t_t$               | Transition time(1)                           | IN1 to IN2 transition,<br>$V_I(IN1) = 3.3\text{ V}$ ,<br>$V_I(IN2) = 5\text{ V}$ ,<br>$V_I(EN) = 0\text{ V}$  | $T_J = 125^\circ\text{C}$ , $C_L = 10\ \mu\text{F}$ ,<br>$I_L = 500\text{ mA}$<br>[Measure transition time as 10–90% rise time or from 3.4 V to 4.8 V on $V_O(OUT)$ ],<br>See Figure 1(b) |      | 40       | 60  |     | 40   | 60  | $\mu\text{s}$ |    |
| $t_{PLH1}$          | Turn-on propagation delay from enable(1)     | $V_I(IN1) = V_I(IN2) = 5\text{ V}$<br>Measured from enable to 10% of $V_O(OUT)$ ,<br>$V_I(VSNS) = 1.5\text{ V}$   | $T_J = 25^\circ\text{C}$ , $C_L = 10\ \mu\text{F}$ ,<br>$I_L = 500\text{ mA}$ ,<br>See Figure 1(a)  |      | 0.5      |     |     | 1    |     | ms            |    |
| $t_{PHL1}$          | Turn-off propagation delay from a disable(1) | $V_I(IN1) = V_I(IN2) = 5\text{ V}$ ,<br>Measured from disable to 90% of $V_O(OUT)$ ,<br>$V_I(VSNS) = 1.5\text{ V}$  | $T_J = 25^\circ\text{C}$ , $C_L = 10\ \mu\text{F}$ ,<br>$I_L = 500\text{ mA}$ ,<br>See Figure 1(a)  |      | 3        |     |     | 5    |     | ms            |    |
| $t_{PLH2}$          | Switch-over rising propagation delay(1)      | Logic 1 to Logic 0 transition on VSNS,<br>$V_I(IN1) = 1.5\text{ V}$ ,<br>$V_I(IN2) = 5\text{ V}$ ,<br>$V_I(EN) = 0\text{ V}$ ,<br>Measured from VSNS to 10% of $V_O(OUT)$ | $T_J = 25^\circ\text{C}$ , $C_L = 10\ \mu\text{F}$ ,<br>$I_L = 500\text{ mA}$ ,<br>See Figure 1(c)  |      | 40       | 100 |     | 40   | 100 | $\mu\text{s}$ |    |
| $t_{PHL2}$          | Switch-over falling propagation delay(1)     | Logic 0 to Logic 1 transition on VSNS<br>$V_I(IN1) = 1.5\text{ V}$ ,<br>$V_I(IN2) = 5\text{ V}$ ,<br>$V_I(EN) = 0\text{ V}$ ,<br>Measured from VSNS to 90% of $V_O(OUT)$  | $T_J = 25^\circ\text{C}$ , $C_L = 10\ \mu\text{F}$ ,<br>$I_L = 500\text{ mA}$ ,<br>See Figure 1(c)  |      | 2        | 3   | 10  | 2    | 5   | 10            | ms |

(1) Not tested in production.

TRUTH TABLE

| $\overline{\text{EN}}$ | $V_{\text{I}}(\text{VSNS}) > 0.8\text{V}$ | $V_{\text{I}}(\text{IN2}) > V_{\text{I}}(\text{IN1})$ | STAT | OUT <sup>(1)</sup> |
|------------------------|---|---|------|--------------------|
| 0                      | Yes                                       | X   | 0    | IN1                |
|                        | No  | No  | 0    | IN1                |
|                        | No  | Yes   | Hi-Z | IN2                |
| 1                      | X   | X   | 0    | Hi-Z               |

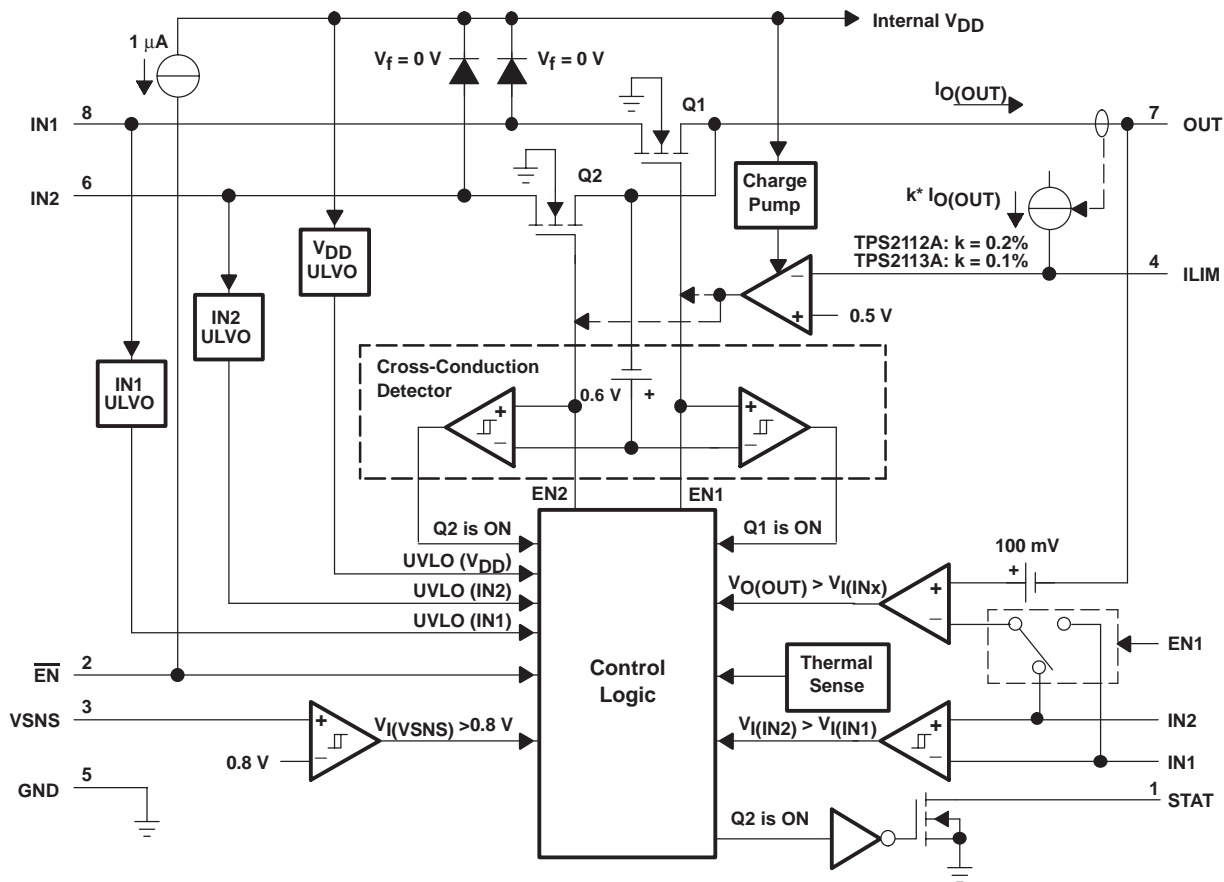
X = Don't care.

(1)The under-voltage lockout circuit causes the output OUT to go Hi-Z if the selected power supply does not exceed the IN1/IN2 UVLO, or if neither of the supplies exceeds the internal  $V_{\text{DD}}$  UVLO.

### Terminal Functions

| TERMINAL NAME          | NO. | I/O | DESCRIPTION   |
|------------------------|-----|-----|---|
| $\overline{\text{EN}}$ | 2   | I   | $\overline{\text{EN}}$ is a TTL- and CMOS-compatible input with a 1- $\mu\text{A}$ pull-up. The truth table shown above illustrates the functionality of $\overline{\text{EN}}$ .                                     |
| GND                    | 5   | I   | Ground  |
| IN1                    | 8   | I   | Primary power switch input. The IN1 switch can be enabled only if the IN1 supply is above the UVLO threshold and at least one supply exceeds the internal $V_{\text{DD}}$ UVLO.                                       |
| IN2                    | 6   | I   | Secondary power switch input. The IN2 switch can be enabled only if the IN2 supply is above the UVLO threshold and at least one supply exceeds the internal $V_{\text{DD}}$ UVLO.                                     |
| ILIM                   | 4   | I   | A resistor $R_{\text{ILIM}}$ from ILIM to GND sets the current limit $I_{\text{L}}$ to $250/R_{\text{ILIM}}$ and $500/R_{\text{ILIM}}$ for the TPS2112A and TPS2113A, respectively.                                   |
| OUT                    | 7   | O   | Power switch output   |
| STAT                   | 1   | O   | STAT is an open-drain output that is Hi-Z if the IN2 switch is ON. STAT pulls low if the IN1 switch is ON or if OUT is Hi-Z (i.e., $\overline{\text{EN}}$ is equal to logic 0)  |
| VSNS                   | 3   | I   | An internal power FET connects OUT to IN1 if the VSNS voltage is greater than 0.8 V. Otherwise, the FET connects OUT to the higher of IN1 and IN2. The truth table shown above illustrates the functionality of VSNS. |

FUNCTIONAL BLOCK DIAGRAM



PARAMETER MEASUREMENT INFORMATION

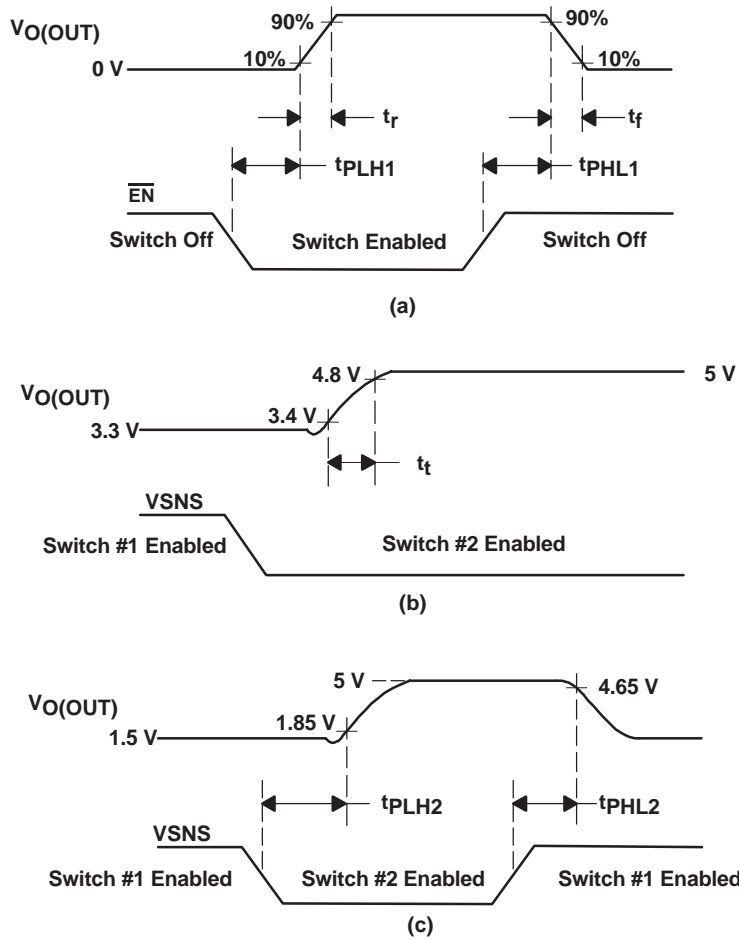
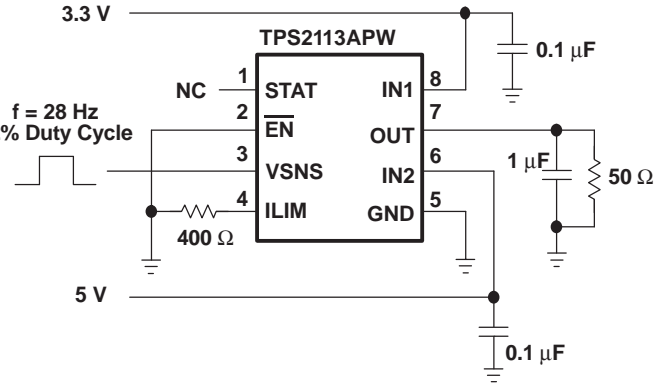
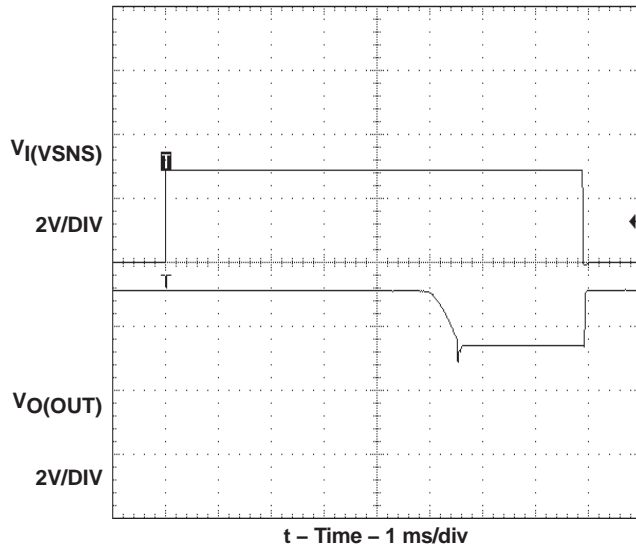


Figure 1. Propagation Delays and Transition Timing Waveforms



TYPICAL CHARACTERISTICS

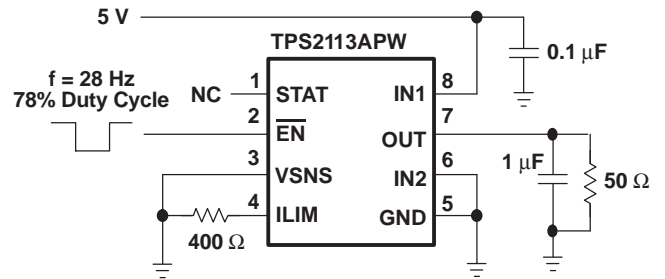
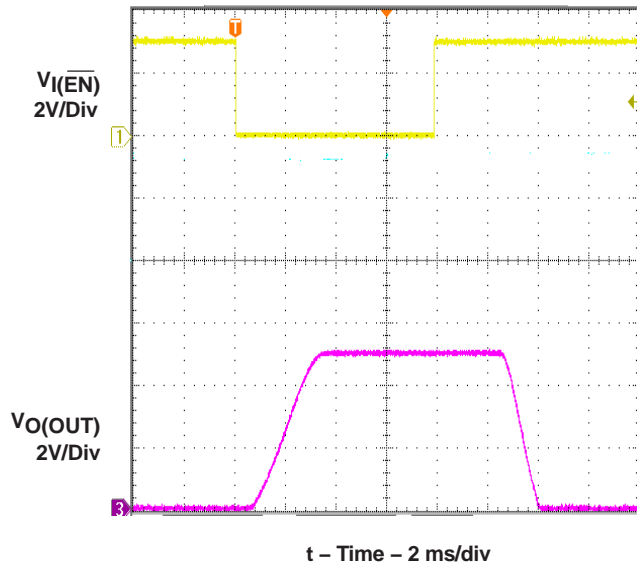
OUTPUT SWITCHOVER RESPONSE



Output Switchover Response Test Circuit

Figure 2

OUTPUT TURN-ON RESPONSE

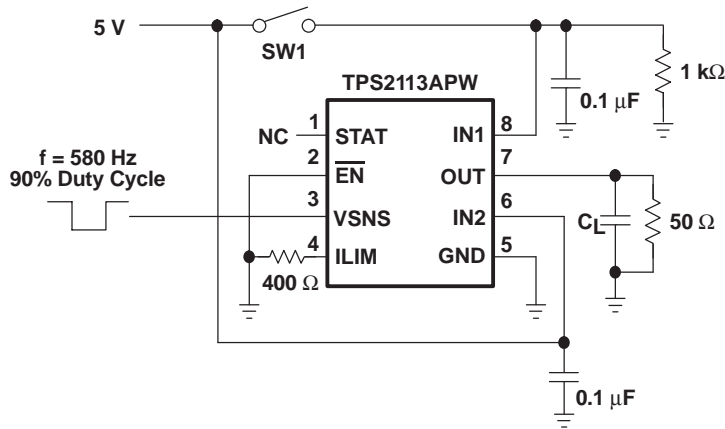
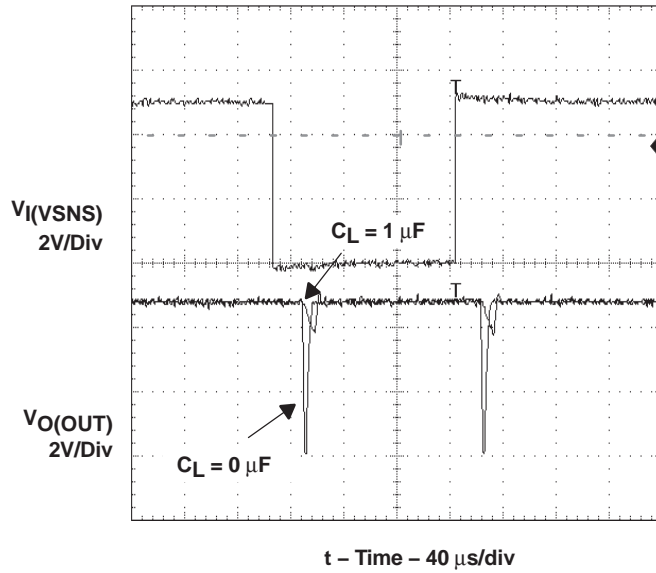


Output Turn-On Response Test Circuit

Figure 3

TYPICAL CHARACTERISTICS

OUTPUT SWITCHOVER VOLTAGE DROOP



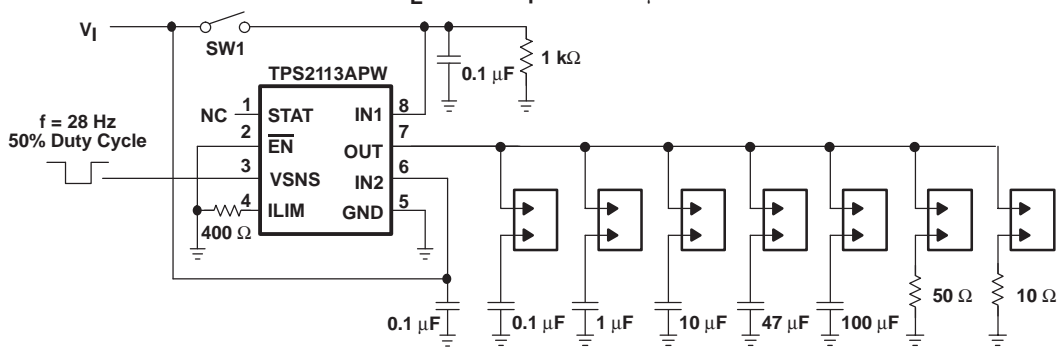
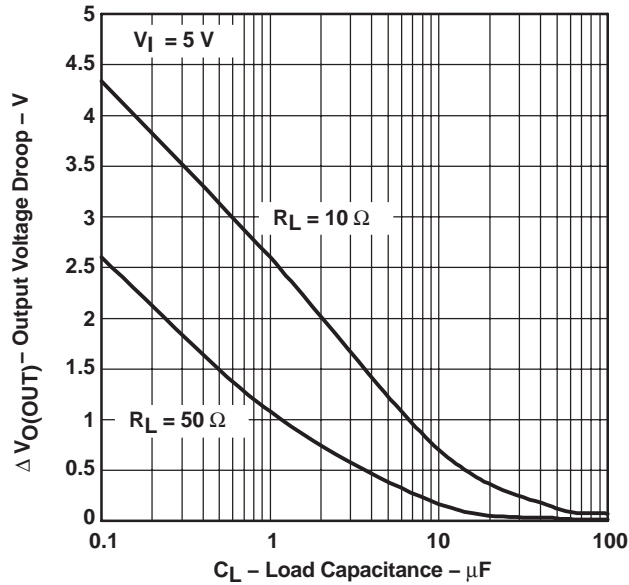
Output Switchover Voltage Droop Test Circuit

Figure 4

NOTE: To initialize the TPS2113A for this test, set input VSNS equal to 0 V, turn on the 5 V supply, and then turn on switch SW1.

TYPICAL CHARACTERISTICS

OUTPUT SWITCHOVER VOLTAGE DROOP  
vs  
LOAD CAPACITANCE



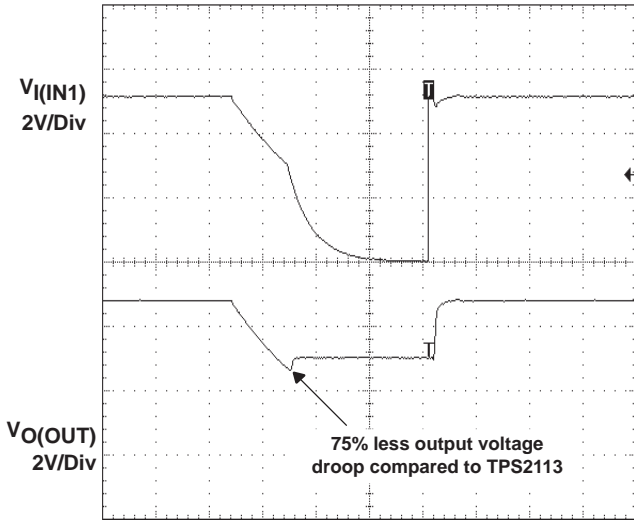
Output Switchover Voltage Droop Test Circuit

Figure 5

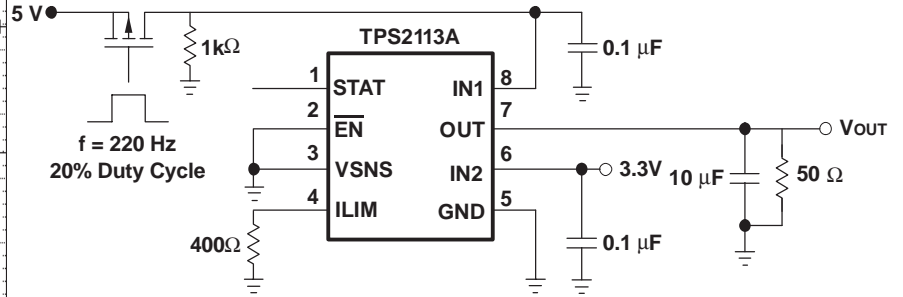
NOTE: To initialize the TPS2113A for this test, set input VSNS equal to 0 V, turn on the supply  $V_I$ , and then turn on switch SW1.

TYPICAL CHARACTERISTICS

AUTO SWITCHOVER VOLTAGE DROOP



t – Time – 250  $\mu$ s/div

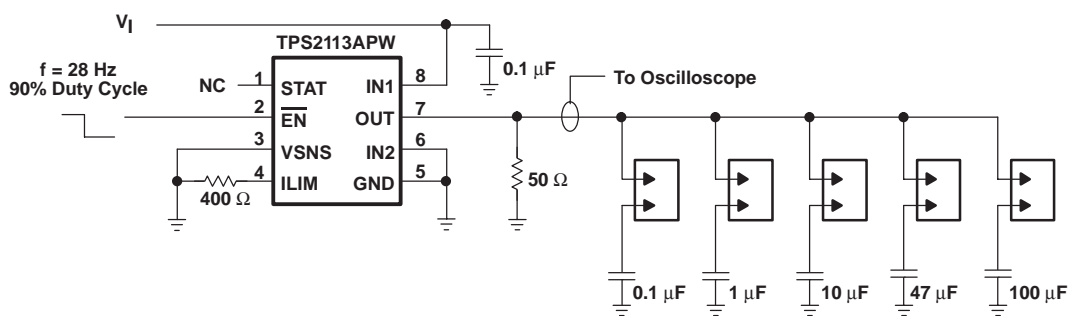
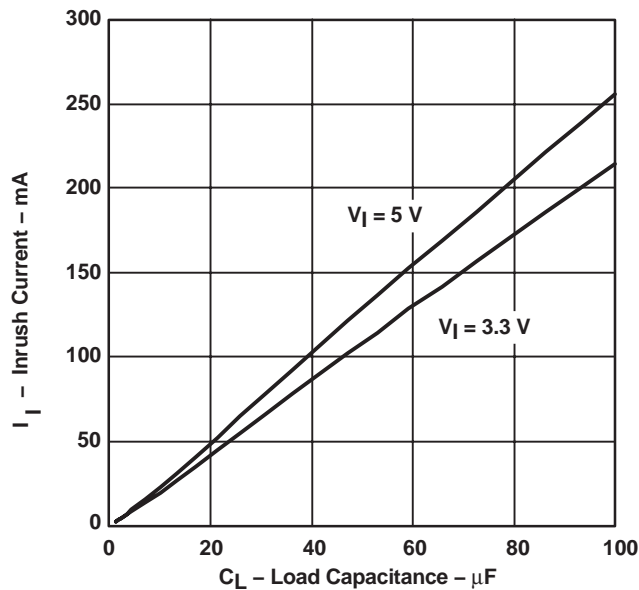


Auto Switchover Voltage Droop Test Circuit

Figure 6

TYPICAL CHARACTERISTICS

INRUSH CURRENT  
VS  
LOAD CAPACITANCE



Output Capacitor Inrush Current Test Circuit

Figure 7

TYPICAL CHARACTERISTICS

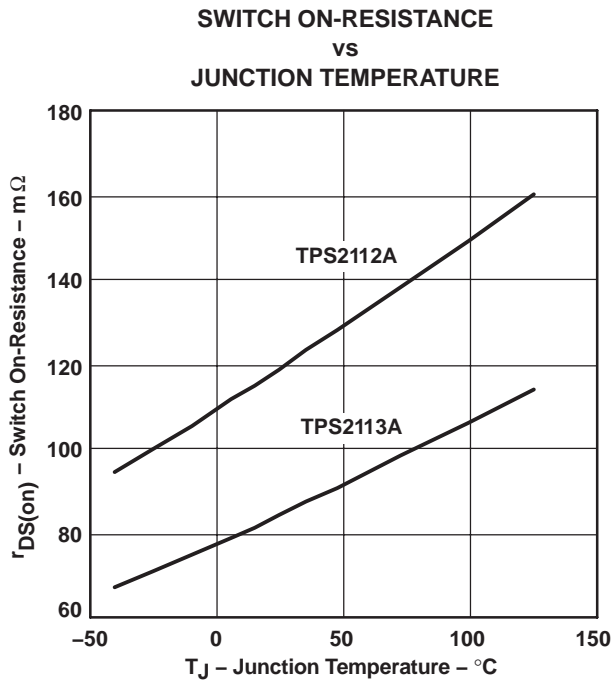


Figure 8

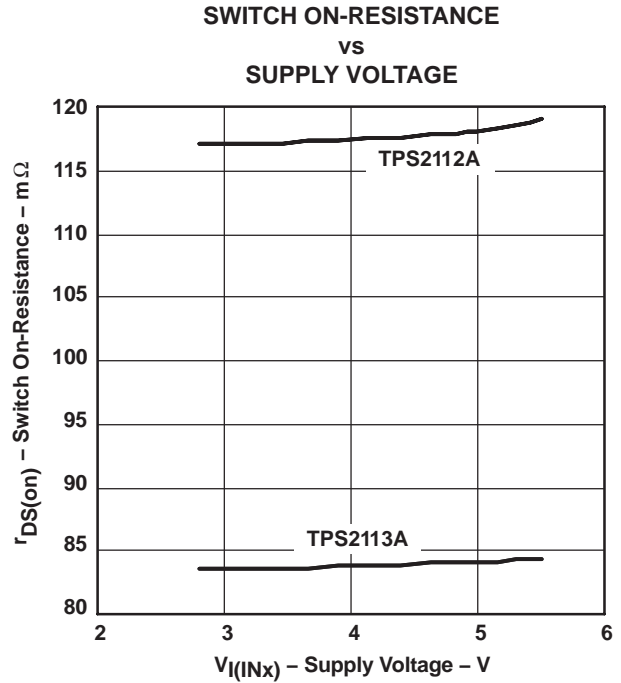


Figure 9

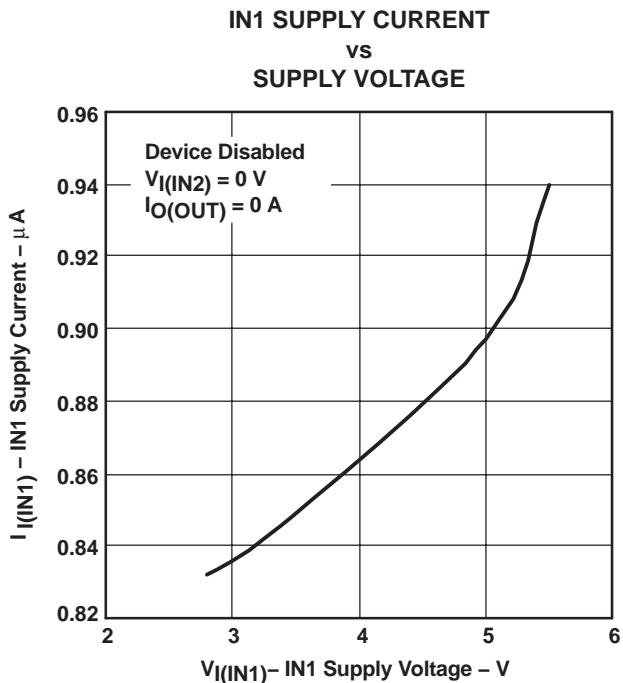


Figure 10

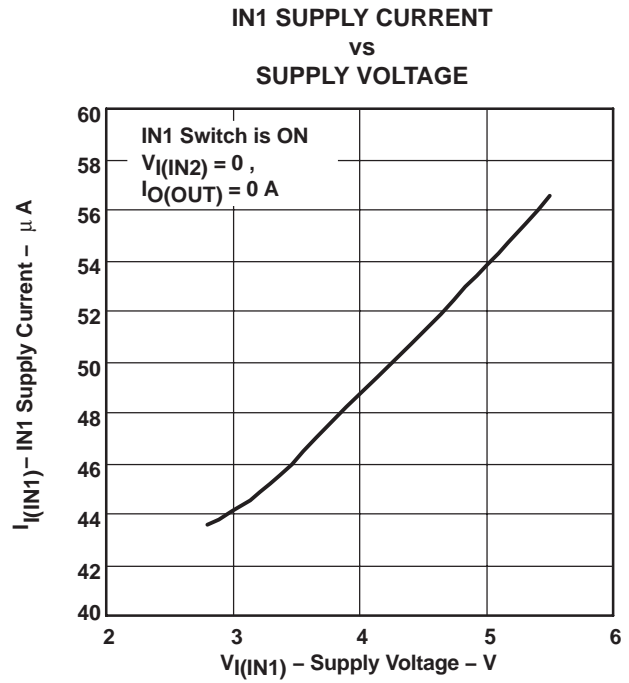
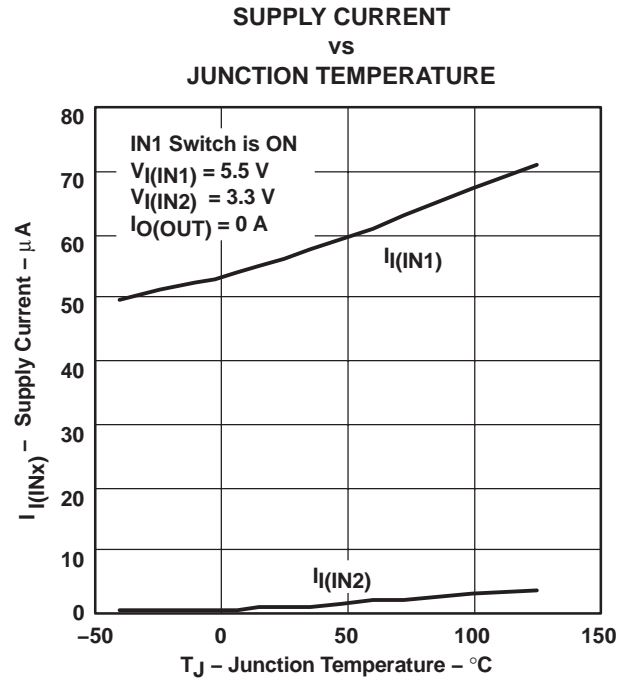
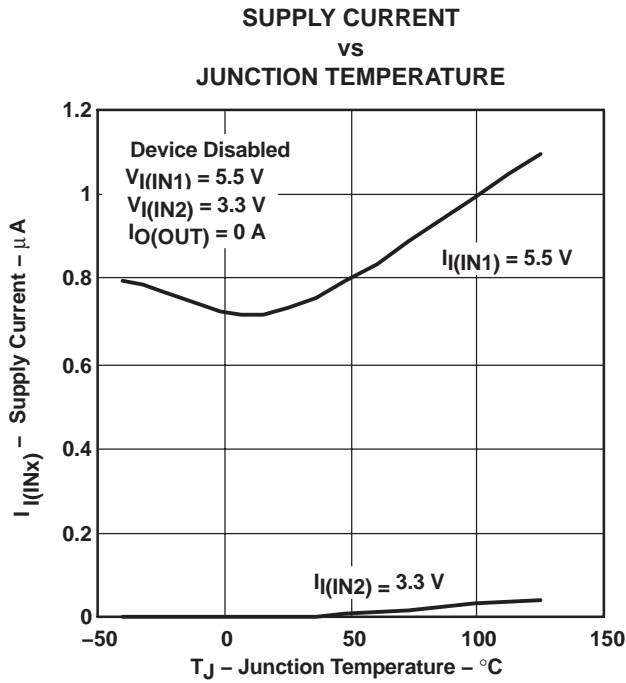


Figure 11

**TYPICAL CHARACTERISTICS**



APPLICATION INFORMATION

Some applications have two energy sources, one of which should be used in preference to another. Figure 14 shows a circuit that will connect IN1 to OUT until the voltage at IN1 falls below a user-specified value. Once the voltage on IN1 falls below this value, the TPS2112A/3A will select the higher of the two supplies. This usually means that the TPS2112A/3A will swap to IN2.

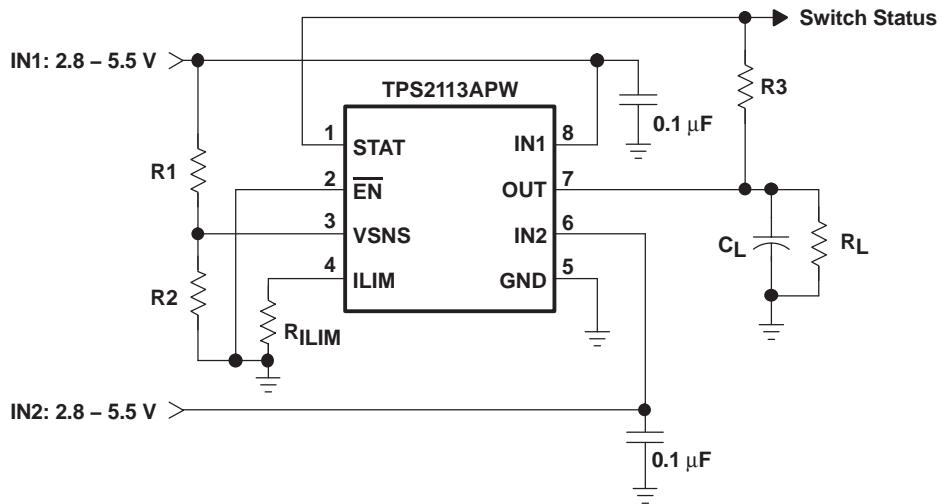


Figure 14. Auto-Selecting for a Dual Power Supply Application

In Figure 15, the multiplexer selects between two power supplies based upon the  $\overline{\text{EN}}$  logic signal. OUT connects to IN1 if  $\overline{\text{EN}}$  is logic 1; otherwise, OUT connects to IN2. The logic thresholds for the  $\overline{\text{EN}}$  terminal are compatible with both TTL and CMOS logic.

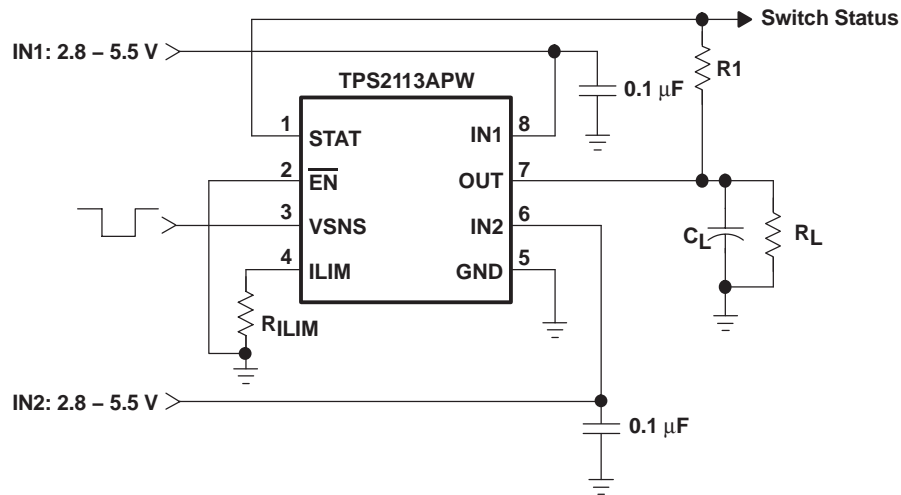


Figure 15. Manually Switching Power Sources



## DETAILED DESCRIPTION

### AUTO-SWITCHING MODE

The TPS2112A/3A only supports the auto-switching mode. In this mode, OUT connects to IN1 if  $V_{I(VSNS)}$  is greater than 0.8 V, otherwise OUT connects to the higher of IN1 and IN2.

The VSNS terminal includes hysteresis equal to 3.75–7.5% of the threshold selected for transition from the primary supply to the higher of the two supplies. This hysteresis helps avoid repeated switching from one supply to the other due to resistive drops.

### N-CHANNEL MOSFETs

Two internal high-side power MOSFETs implement a single-pole double-throw (SPDT) switch. Digital logic selects the IN1 switch, IN2 switch, or no switch (Hi-Z state). The MOSFETs have no parallel diodes so output-to-input current cannot flow when the FET is off. An integrated comparator prevents turn-on of a FET switch if the output voltage is greater than the input voltage.

### CROSS-CONDUCTION BLOCKING

The switching circuitry ensures that both power switches will never conduct at the same time. A comparator monitors the gate-to-source voltage of each power FET and allows a FET to turn on only if the gate-to-source voltage of the other FET is below the turn-on threshold voltage.

### REVERSE-CONDUCTION BLOCKING

When the TPS211xA switches from a higher-voltage supply to a lower-voltage supply, current can potentially flow back from the load capacitor into the lower-voltage supply. To minimize such reverse conduction, the TPS211xA will not connect a supply to the output until the output voltage has fallen to within 100 mV of the supply voltage. Once a supply has been connected to the output, it will remain connected regardless of output voltage.

### CHARGE PUMP

The higher of supplies IN1 and IN2 powers the internal charge pump. The charge pump provides power to the current limit amplifier and allows the output FET gate voltage to be higher than the IN1 and IN2 supply voltages. A gate voltage that is higher than the source voltage is necessary to turn on the N-channel FET.

### CURRENT LIMITING

A resistor  $R_{ILIM}$  from ILIM to GND sets the current limit to  $250/R_{ILIM}$  and  $500/R_{ILIM}$  for the TPS2112A and TPS2113A, respectively. Setting resistor  $R_{ILIM}$  equal to zero is not recommended as that disables current limiting.

### OUTPUT VOLTAGE SLEW-RATE CONTROL

The TPS2112A/3A slews the output voltage at a slow rate when OUT switches to IN1 or IN2 from the Hi-Z state (see *Truth Table*). A slow slew rate limits the inrush current into the load capacitor. High inrush currents can glitch the voltage bus and cause a system to hang up or reset. It can also cause reliability issues—like pit the connector power contacts, when hot-plugging a load such as a PCI card. The TPS2112A/3A slews the output voltage at a much faster rate when OUT switches between IN1 and IN2. The fast rate minimizes the output voltage droop and reduces the output voltage hold-up capacitance requirement.

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TPS2112APW       | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TPS2112APWG4     | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TPS2112APWR      | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TPS2112APWRG4    | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TPS2113ADRBR     | PREVIEW               | SON          | DRB             | 8    | 3000        | TBD                     | Call TI          | Call TI                      |
| TPS2113ADRBT     | PREVIEW               | SON          | DRB             | 8    | 250         | TBD                     | Call TI          | Call TI                      |
| TPS2113APW       | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TPS2113APWG4     | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TPS2113APWR      | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| TPS2113APWRG4    | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

<sup>(1)</sup> 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.

<sup>(2)</sup> 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)

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

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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 |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS2112APWR | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TPS2113APWR | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 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) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS2112APWR | TSSOP        | PW              | 8    | 2000 | 346.0       | 346.0      | 29.0        |
| TPS2113APWR | TSSOP        | PW              | 8    | 2000 | 346.0       | 346.0      | 29.0        |

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN

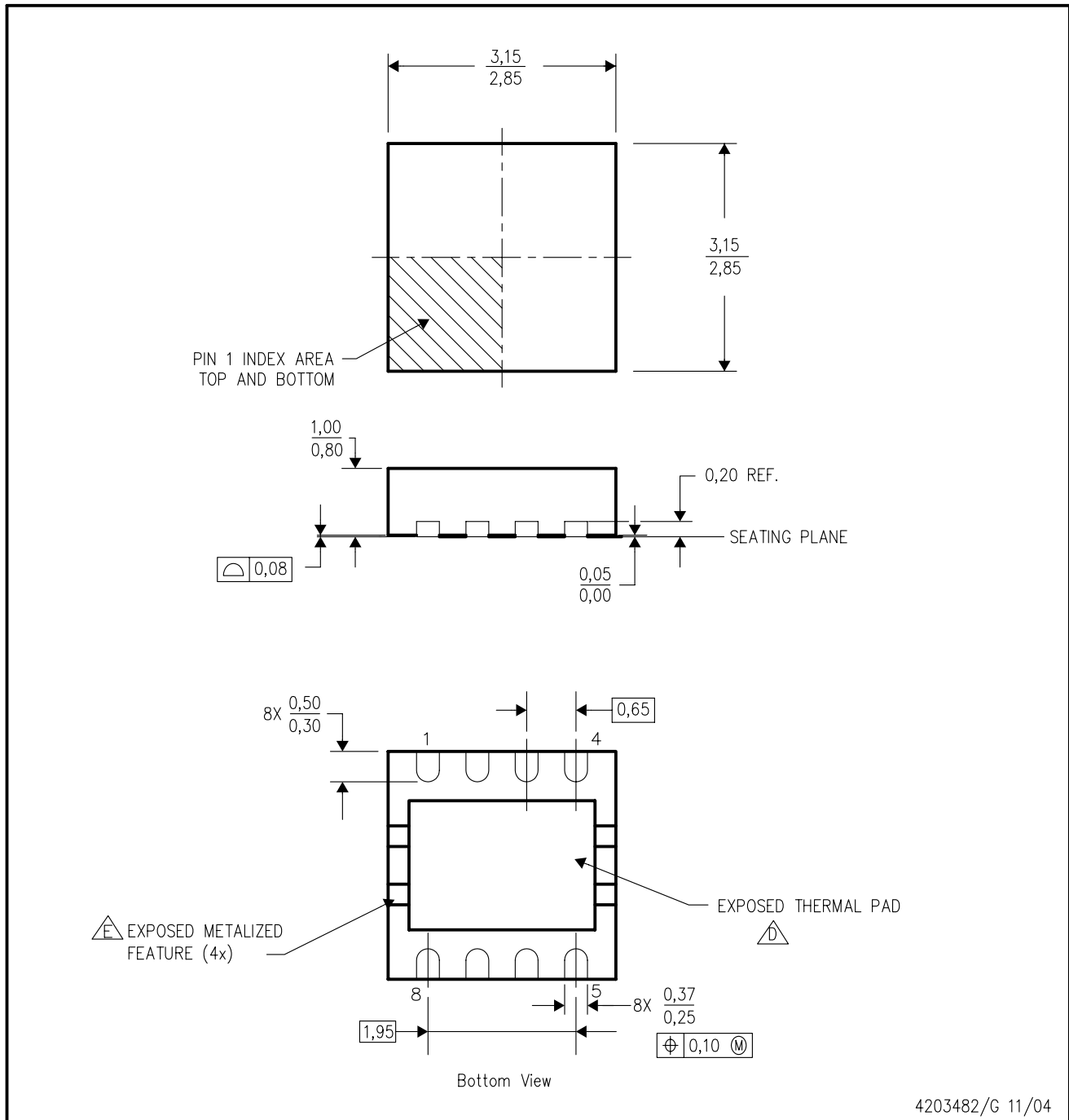




4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

DRB (S-PDSO-N8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Small Outline No-Lead (SON) package configuration.
  -  The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.
  -  Metalized features are supplier options and may not be on the package.

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| Security           | <a href="http://www.ti.com/security">www.ti.com/security</a>             |
| Telephony          | <a href="http://www.ti.com/telephony">www.ti.com/telephony</a>           |
| Video & Imaging    | <a href="http://www.ti.com/video">www.ti.com/video</a>                   |
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