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Low Quiescent Current, Accurate Programmable-Delay Supervisory Circuit

FEATURES

- Power-On Reset Generator with Adjustable Delay Time: 1.25ms to 10s
- Very Low Quiescent Current: 2.4μA typ
- High Threshold Accuracy: 0.5% typ
- Fixed Threshold Voltages for Standard Voltage Rails from 0.9V to 5V and Adjustable Voltage Down to 0.4V Are Available
- Manual Reset (MR) Input
- Open-Drain RESET Output
- Temperature Range: -40°C to +125°C
- Small SOT23 and 2mm × 2mm QFN Packages

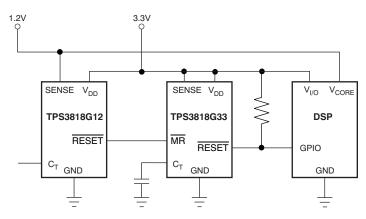
APPLICATIONS

- DSP or Microcontroller Applications
- Notebook/Desktop Computers
- PDAs/Hand-Held Products
- Portable/Battery-Powered Products
- FPGA/ASIC Applications

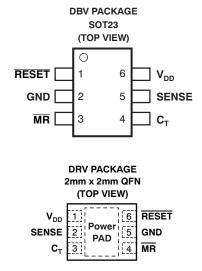
DESCRIPTION

The TPS3818xxx family of microprocessor supervisory circuits monitor system voltages from 0.4V to 5.0V, asserting an open-drain RESET signal when the SENSE voltage drops below a preset threshold or when the manual reset (MR) pin drops to a logic low. The RESET output remains low for the user-adjustable delay time after the SENSE voltage and manual reset (MR) return above the respective thresholds.

The TPS3818 uses a precision reference to achieve 0.5% threshold accuracy for $V_{\text{IT}} \leq 3.3 \text{V}$. The reset delay time can be set to 20ms by disconnecting the C_{T} pin, 300ms by connecting the C_{T} pin to V_{DD} using a resistor, or can be user-adjusted between 1.25ms and 10s by connecting the C_{T} pin to an external capacitor. When used with an external capacitor, the TPS3818xxx gives a more accurate delay time than the similar TPS3808xxx device. The TPS3818 has a very low typical quiescent current of 2.4 μ A so it is well-suited to battery-powered applications. It is available in either a small SOT23 and an ultra-small 2mm × 2mm QFN PowerPADTM package, and is fully specified over a temperature range of -40°C to +125°C (T_I).



Typical Application Circuit





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

PowerPAD is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.





This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ORDERING INFORMATION(1)

PRODUCT	NOMINAL SUPPLY VOLTAGE ⁽²⁾	THRESHOLD VOLTAGE (V _{IT})
TPS3818G01	Adjustable	0.405V
TPS3818G09	0.9V	0.84V
TPS3818G12	1.2V	1.12V
TPS3818G125	1.25V	1.16V
TPS3818G15	1.5V	1.40V
TPS3818G18	1.8V	1.67V
TPS3818G25	2.5V	2.33V
TPS3818G30	3.0V	2.79V
TPS3818G33	3.3V	3.07V
TPS3818G50	5.0V	4.65V

⁽¹⁾ For the most current package and ordering information see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

ABSOLUTE MAXIMUM RATINGS(1)

Over operating junction temperature range, unless otherwise noted.

	TPS3818	UNIT
Input voltage range, V _{DD}	-0.3 to 7.0	V
C _T voltage range, V _{CT}	-0.3 to V _{DD} + 0.3	V
Other voltage ranges: V _{RESET} , V _{MR} , V _{SENSE}	-0.3 to 7	V
RESET pin current	5	mA
Operating junction temperature range, T _J ⁽²⁾	-40 to +150	°C
Storage temperature range, T _{STG}	-65 to +150	°C
ESD rating, HBM	2	kV
ESD rating, CDM	500	V

⁽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 the Electrical Characteristics is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

(2) As a result of the low dissipated power in this device, it is assumed that $T_J = T_A$.

⁽²⁾ Custom threshold voltages from 0.82V to 3.3V, 4.4V to 5.0V are available through the use of factory EEPROM programming. Minimum order quantities apply. Contact factory for details and availability.

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ELECTRICAL CHARACTERISTICS

 $1.7\text{V} \le \text{V}_{\text{DD}} \le 6.5\text{V}$, $R_{\text{LRESET}} = 100\text{k}\Omega$, $C_{\text{LRESET}} = 50\text{pF}$, over operating temperature range ($T_{\text{J}} = -40^{\circ}\text{C}$ to +125°C), unless otherwise noted. Typical values are at $T_{\text{J}} = +25^{\circ}\text{C}$.

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT	
.,	Land annula mana		-40°C < T _J < +125°C	1.7		6.5		
V_{DD}	Input supply range		0°C < T _J < +85°C	1.65		6.5	V	
	Supply surrent (surrent	into \ nin\	$\frac{V_{DD}}{MR} = 3.3V$, RESET not asserted MR, RESET, C _T open		2.4	5.0	μΑ	
I _{DD}	Supply current (current	into v _{DD} pin)	$\frac{V_{DD}}{MR} = 6.5V, \overline{RESET}$ not asserted MR, \overline{RESET} , C_T open		2.7	6.0	μΑ	
1/			$1.3V \le V_{DD} < 1.8V, I_{OL} = 0.4mA$			0.3	V	
V_{OL}	Low-level output voltage	;	$1.8V \le V_{DD} \le 6.5V$, $I_{OL} = 1.0mA$			0.4	V	
	Power-up reset voltage ⁽	1)	V_{OL} (max) = 0.2V, I_{RESET} = 15 μ A			0.8	V	
		TPS3818G01		-2.0	±1.0	+2.0		
	Negative-going input threshold accuracy	V _{IT} ≤ 3.3V		-1.5	±0.5	+1.5		
V_{IT}		$3.3V < V_{IT} \le 5.0V$		-2.0	±1.0	+2.0	%	
		V _{IT} ≤ 3.3V	-40°C < T _J < +85°C	-1.25	±0.5	+1.25		
		$3.3V < V_{IT} \le 5.0V$	-40°C < T _J < +85°C	-1.5	±0.5	+1.5		
		TPS3818G01			1.5	3.0		
V_{HYS}	V _{HYS} Hysteresis on V _{IT} pin		-40°C < T _J < +85°C		1.0 2.0	$%V_{IT}$		
		Fixed versions			1.0	2.5		
R _{MR}	MR Internal pull-up resistance			70	90		kΩ	
	Input current at	TPS3818G01	V _{SENSE} = V _{IT}	-25		25	nA	
ISENSE	SENSE pin	pin Fixed versions V _{SENSE} = 6.5V			1.7		μΑ	
I _{OH}	RESET leakage current		V _{RESET} = 6.5V, RESET not asserted			300	nA	
•	Input capacitance,	C _T pin	V _{IN} = 0V to V _{DD}		5		_	
C _{IN}	any pin	Other pins	V _{IN} = 0V to 6.5V	5			pF	
V _{IL}	MR logic low input	•		0		0.3 V _{DD}		
V_{IH}	MR logic high input			0.7 V _{DD}		V_{DD}	V	
	Input pulse width	SENSE	$V_{IH} = 1.05V_{IT}, V_{IL} = 0.95V_{IT}$		20			
t _w	to RESET	MR	$V_{IH} = 0.7V_{DD}, V_{IL} = 0.3V_{DD}$	0.001			μs	
	 (2)	C _T = Open		12	20	28	ms	
t _d	RESET delay time (2)	T delay time $^{(2)}$ See Timing Diagram $C_T = V_{DD}$		180	300	420	ms	
V _{CT}	CT pin (RESET delay tin threshold (3)	me) comparator		1.211	1.23	1.249	V	
I _{CT}	CT pin (RESET delay tir current (3)	me) charging	R_{CT} = 2M Ω (resistor between C_T and GND)	190	220	250	nA	
	Propagation delay	MR to RESET	$V_{IH} = 0.7 V_{DD}, V_{IL} = 0.3 V_{DD}$		150		ns	
t _{pHL}	High to low level RESET delay	SENSE to RESET	V _{IH} = 1.05V _{IT} , V _{IL} = 0.95V _{IT}		20		μs	
θ_{JA}	Thermal resistance, june	ction-to-ambient			290		°C/W	

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 ⁽¹⁾ The lowest supply voltage (V_{DD}) at which RESET becomes active. T_{rise(VDD)} ≥ 15μs/V.
 (2) The delay time accuracy without external capacitor is the same as that of the TPS3808xxx. This specification is included here for TPS3808xxx device comparison. The combined RESET delay time accuracy from V_{CT} and I_{CT} is ±15%.



FUNCTIONAL BLOCK DIAGRAMS

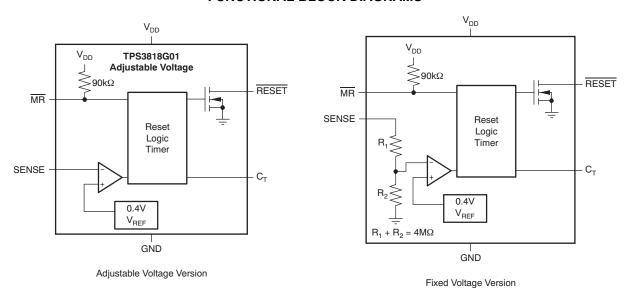


Figure 1. Adjustable and Fixed Voltage Versions

PIN ASSIGNMENTS

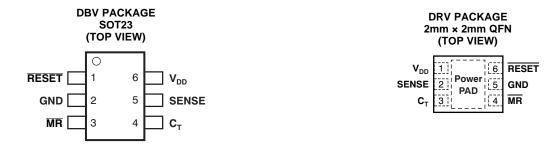


Table 1. TERMINAL FUNCTIONS

TERMINAL		
NAME	SOT23 (DBV) PIN NO.	DESCRIPTION
RESET	1	RESET is an open-drain output that is driven to a low impedance state when RESET is asserted (either the SENSE input is lower than the threshold voltage (V_{IT}) or the \overline{MR} pin is set to a logic low). RESET remains low (asserted) for the reset period after both SENSE is above V_{IT} and \overline{MR} is set to a logic high. A pull-up resistor from 10kΩ to 1MΩ should be used on this pin, and allows the reset pin to attain voltages higher than V_{DD} .
GND	2	Ground
MR	3	Driving the manual reset pin (\overline{MR}) low asserts \overline{RESET} . \overline{MR} is internally tied to V_{DD} by a $90k\Omega$ pull-up resistor.
СТ	4	Reset period programming pin. Connecting this pin to V_{DD} through a $40k\Omega$ to $200k\Omega$ resistor or leaving it open results in fixed delay times (see Electrical Characteristics). Connecting this pin to a ground referenced capacitor $\geq 100pF$ gives a user-programmable delay time. See the Selecting the Reset Delay Time section for more information.
SENSE	5	This pin is connected to the voltage to be monitored. If the voltage at this terminal drops below the threshold voltage V_{IT} , then \overline{RESET} is asserted.
V_{DD}	6	Supply voltage. It is good analog design practice to place a 0.1µF ceramic capacitor close to this pin.
PowerPAD		PowerPAD. Connect to ground plane to enhance thermal performance of package.



TIMING DIAGRAM

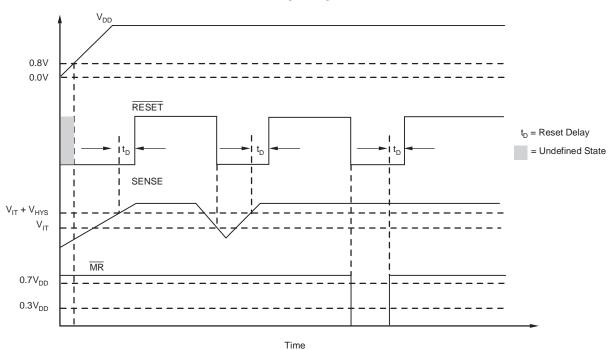


Figure 2. TPS3818 Timing Diagram Showing MR and SENSE Reset Timing

TRUTH TABLE

MR	SENSE > V _{IT}	RESET
L	0	L
L	1	L
Н	0	L
Н	1	Н



TYPICAL CHARACTERISTICS

At T_J = +25°C, V_{DD} = 3.3V, R_{LRESET} = 100k Ω , and C_{LRESET} = 50pF, unless otherwise noted.

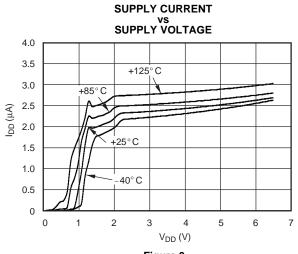


Figure 3.

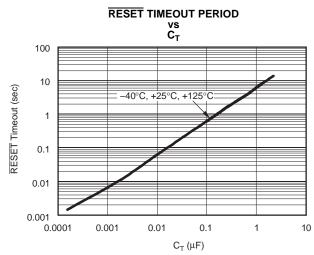
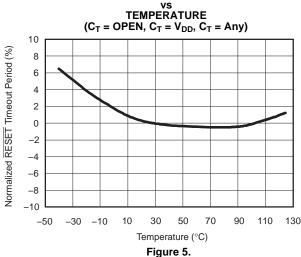
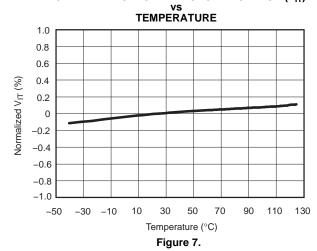


Figure 4.

NORMALIZED RESET TIMEOUT PERIOD



NORMALIZED SENSE THRESHOLD VOLTAGE (VIT)



MAXIMUM TRANSIENT DURATION AT SENSE VS
SENSE THRESHOLD OVERDRIVE VOLTAGE

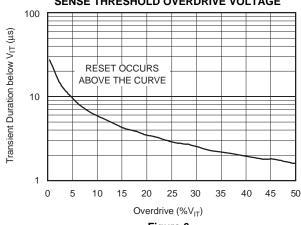


Figure 6.

LOW-LEVEL RESET VOLTAGE

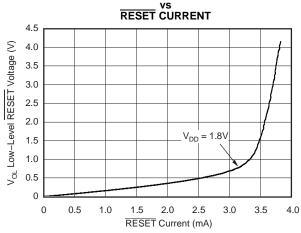


Figure 8.



TYPICAL CHARACTERISTICS (continued)

At T_J = +25°C, V_{DD} = 3.3V, R_{LRESET} = 100k Ω , and C_{LRESET} = 50pF, unless otherwise noted.

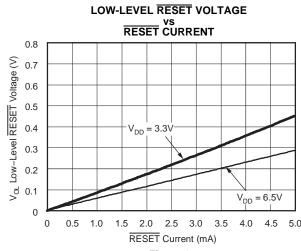


Figure 9.



DEVICE OPERATION

The TPS3818 microprocessor supervisory product family is designed to assert a RESET signal when either the SENSE pin voltage drops below V_{IT} or the manual reset (MR) is driven low. The RESET output remains asserted for a user-adjustable time after both the manual reset (MR) and SENSE voltages return above the respective thresholds. A broad range of voltage threshold and reset delay time adjustments are available, allowing these devices to be used in a wide array of applications. Reset threshold voltages can be factory-set from 0.82V to 3.3V or from 4.4V to 5.0V, while the TPS3818G01 can be set to any voltage above 0.405V using an external resistor divider. Two preset delay times are also user-selectable: connecting the C_{T} pin to V_{DD} results in a 300ms reset delay, while leaving the C_T pin open yields a 20ms reset delay. In addition, connecting a capacitor between C_T and GND allows the designer to select any reset delay period from 1.25ms to 10s.

RESET OUTPUT

A typical application of the TPS3818G25 used with the OMAP1510 processor is shown in Figure 10. The open-drain RESET output is typically connected to the RESET input of a microprocessor. A pull-up resistor must be used to hold this line high when RESET is not asserted. The RESET output is undefined for voltage below 0.8V, but this is normally not a problem because most microprocessors do not function below this voltage. RESET remains high (unasserted) as long as SENSE is above its threshold (VIT) and the manual reset (MR) is logic high. If either SENSE falls below VIT or MR is driven low, RESET is asserted, driving the RESET pin to a low impedance.

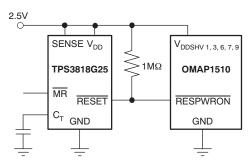


Figure 10. Typical Application of the TPS3818 with an OMAP Processor

Once MR is again logic high and SENSE is above V_{IT} + V_{HYS} (the threshold hysteresis), a delay circuit is enabled that holds RESET low for a specified reset delay period. Once the reset delay has expired, the RESET pin goes to a high impedance state. The pull-up resistor from the open-drain RESET to the

supply line can be used to allow the reset signal for the microprocessor to have a voltage higher than V_{DD} (up to 6.5V). The pull-up resistor should be no smaller than $10k\Omega$ as a result of the finite impedance of the RESET line.

SENSE INPUT

The SENSE input provides a terminal at which any system voltage can be monitored. If the voltage on this pin drops below $V_{\rm IT}$, then RESET is asserted. The comparator has a built-in hysteresis to ensure smooth RESET assertions and de-assertions. It is good analog design practice to put a 1nF to 10nF bypass capacitor on the SENSE input to reduce sensitivity to transients and layout parasitics.

The TPS3818G01 can be used to monitor any voltage rail down to 0.405V using the circuit shown in Figure 11.

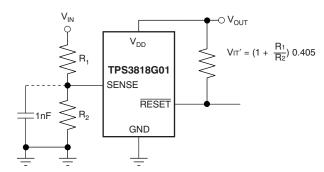


Figure 11. Using the TPS3818G01 to Monitor a User-Defined Threshold Voltage

MANUAL RESET (MR) INPUT

The manual reset (\overline{MR}) input allows a processor or other logic <u>circ</u>uit to in<u>itiate a</u> reset. A logic <u>low</u> $(0.3V_{DD})$ on MR causes RESET to assert. After MR returns to a <u>logic high</u> and SENSE is above its reset threshold, RESET is de-asserted after the user-defined reset delay expires. Note that MR is internally tied to V_{DD} using a $90k\Omega$ resistor so this pin can be left unconnected if MR is not used.

See Figure 12 for how $\overline{\text{MR}}$ can be used to monitor multiple system voltages. Note that if the logic signal driving $\overline{\text{MR}}$ does not go fully to V_{DD} , there will be some additional current draw into \underline{V}_{DD} as a result of the internal pull-up resistor on $\overline{\text{MR}}$. To minimize current draw, a logic-level FET can be used as illustrated in Figure 13.



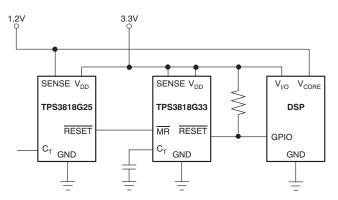


Figure 12. Using MR to Monitor Multiple System Voltages

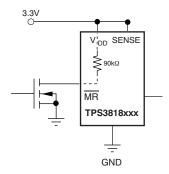


Figure 13. Using an External MOSFET to Minimize I_{DD} When MR Signal Does Not Go to V_{DD}

SELECTING THE RESET DELAY TIME

The TPS3818 has three options for setting the RESET delay time as shown in Figure 14. Figure 14a shows the configuration for a fixed 300ms typical delay time by tying C_T to V_{DD} ; a resistor from 40kΩ to 200kΩ must be used. Supply current is not affected

by the choice of resistor. Figure 14b shows a fixed 20ms delay time by leaving the C_T pin open. Figure 14c shows a ground referenced capacitor connected to C_T for a user-defined program time between 1.25ms and 10s.

The capacitor C_T should be $\geq 100 pF$ nominal value in order for the TPS3818xxx to recognize that the capacitor is present. The capacitor value for a given delay time can be calculated using the following equation:

$$C_T (nF) = [t_D (s) - 0.5 \times 10^{-3} (s)] \times 175$$
 (1)

The reset delay time is determined by the time it takes an on-chip precision 220nA current source to charge the external capacitor to 1.23V. When a RESET is asserted the capacitor is discharged. When the RESET conditions are cleared, the internal current source is enabled and begins to charge the external capacitor. When the voltage on this capacitor reaches 1.23V, RESET is de-asserted. Note that a low leakage type capacitor such as a ceramic should be used, and that stray capacitance around this pin may cause errors in the reset delay time.

IMMUNITY TO SENSE PIN VOLTAGE TRANSIENTS

The TPS3818 is relatively immune to short negative transients on the SENSE pin. Sensitivity to transients depends on threshold overdrive, as shown in the Maximum Transient Duration at Sense vs Sense Threshold Overdrive Voltage graph (Figure 6) in the Typical Characteristics section.

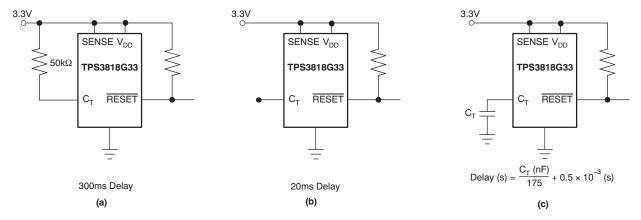


Figure 14. Configuration Used to Set the RESET Delay Time

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PACKAGING INFORMATION

Orderable part number	Status	Material type	Package Pins	Package qty Carrier	RoHS	Lead finish/ Ball material	MSL rating/ Peak reflow	Op temp (°C)	Part marking (6)
TPS3818G25DRVT	Active	Production	WSON (DRV) 6	250 SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	CHJ
TPS3818G25DRVT.B	Active	Production	WSON (DRV) 6	250 SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	CHJ

⁽¹⁾ Status: For more details on status, see our product life cycle.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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⁽²⁾ Material type: When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

⁽⁴⁾ Lead finish/Ball material: Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ MSL rating/Peak reflow: The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ Part marking: There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

PACKAGE MATERIALS INFORMATION

www.ti.com 3-Aug-2017

TAPE AND REEL INFORMATION





	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

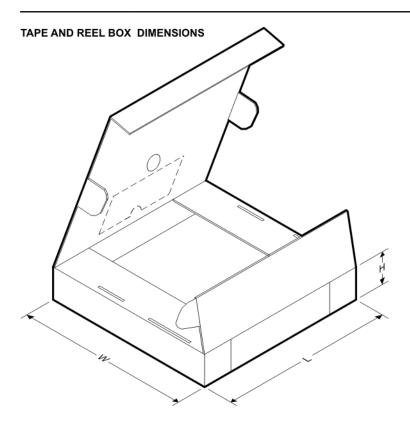
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing			Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS3818G25DRVT	WSON	DRV	6	250	179.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2

www.ti.com 3-Aug-2017



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS3818G25DRVT	WSON	DRV	6	250	203.0	203.0	35.0



Images above are just a representation of the package family, actual package may vary. Refer to the product data sheet for package details.

4206925/F







NOTES:

- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

 2. This drawing is subject to change without notice.

 3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.





NOTES: (continued)

- 4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature
- number SLUA271 (www.ti.com/lit/slua271).

 5. Vias are optional depending on application, refer to device data sheet. If some or all are implemented, recommended via locations are shown.





NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.







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- 1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

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NOTES: (continued)

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