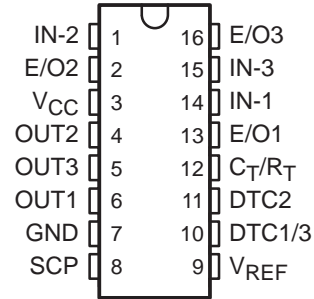


- Low Voltage Operation . . . 2.5 V to 7 V
- Low Power . . . 3.5 mA  
(f = 500 kHz, Duty = 50%)
- Internal Undervoltage Lockout Protection
- Internal Short Circuit Protection
- Wide Operating Frequency . . . 50 kHz to 1 MHz
- Internal Precision Reference . . . 1.25 V ±1% (25°C)
- On/Off Switch for CH1/3 Pair and Ch2 (see Function Table)
- 0 to 100% Dead Time Control
- Totem Pole Output Stage
- Small Package . . . 16 Pin TSSOP

PW PACKAGE  
(TOP VIEW)



## description

The TPS5100 is a triple PWM control circuit, primarily designed to compose the power supply for LCD display. Each PWM channel has own error amplifier, PWM comparator, dead-time control and output driver. The trimmed voltage reference, oscillator, undervoltage lockout and short circuit protection are common for all channels.

This device includes two boost exclusive circuits (ch1,3) and a buck-boost exclusive circuit (ch2). The operating frequency is set with external resistor and capacitor, and dead time is continuously adjustable from 0% to 100% duty cycle with resistive divider network. Soft start function can be implemented by adding a capacitor to dead time divider network. Two dead time control inputs are assigned for ch1,3 pair and ch2 individually and each dead time control input can be used to control on/off operation. TPS5100 can operate from 2.5 V supply voltage and ch1,3 pair and ch2 operate with reverse phase switching each other to achieve efficient operation in low power and battery powered system.

The TPS5100 is characterized for operation from -20°C to 85°C.

FUNCTION TABLE

CONDITION	OUTPUT		
	CH-1	CH-2	CH-3
DTC1/3 > 0.3 V, DTC2 > 0.3 V	ON H	ON L	ON H
DTC1/3 > 0.3 V, DTC2 < 0.2 V	ON H	OFF H	ON H
DTC1/3 < 0.2 V, DTC2 > 0.3 V	OFF L	ON L	OFF L
DTC1/3 < 0.2 V, DTC2 < 0.2 V	OFF L	OFF H	OFF L

AVAILABLE OPTIONS

T <sub>A</sub>	PACKAGE
	TSSOP (PW)
-20°C to 85°C	TPS5100PW

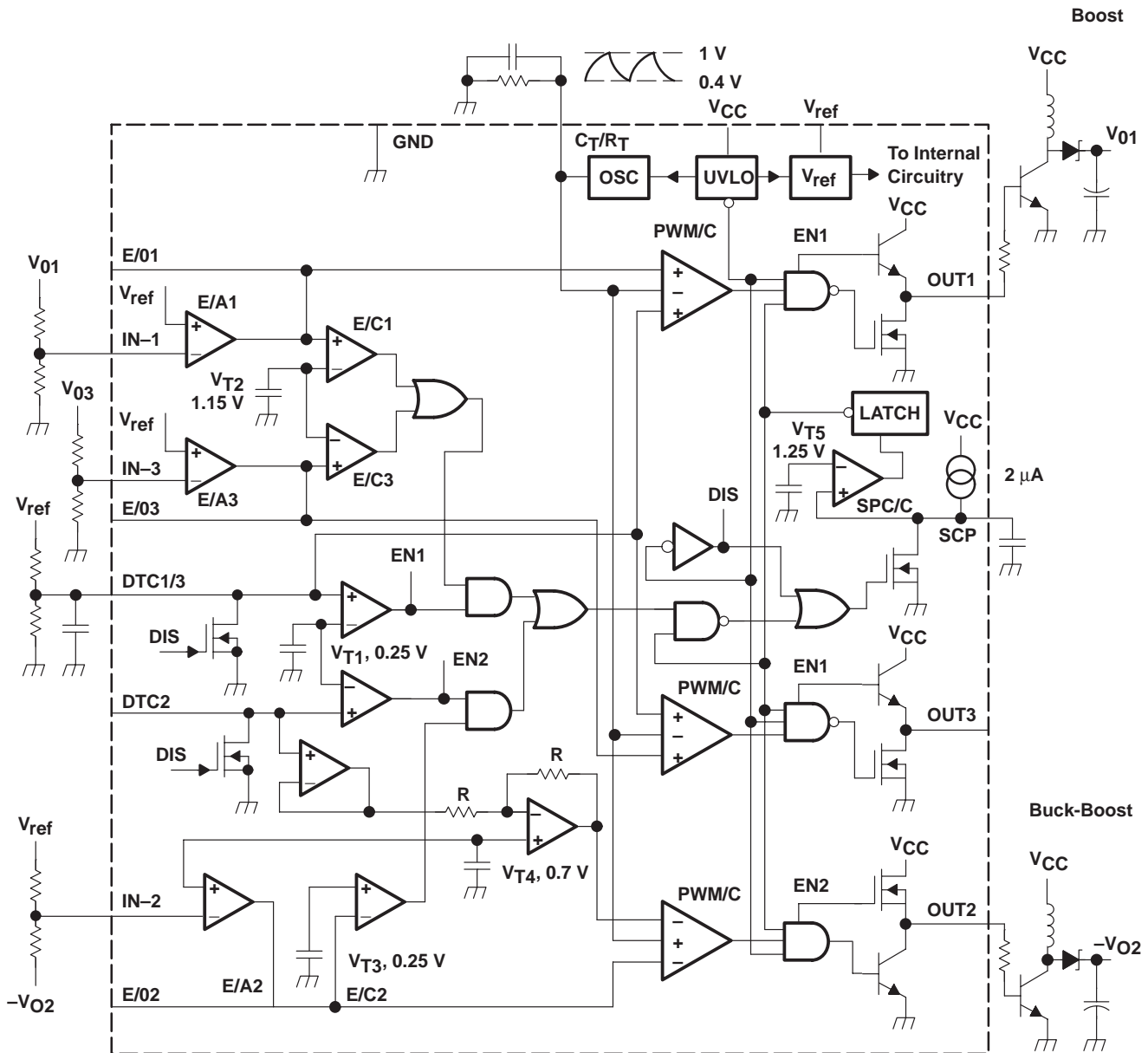


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# TPS5100 TRIPLE-CHANNEL PWM CONTROL CIRCUITS

SLVS169 – JANUARY 2000

## functional block diagram



NOTE A: All voltages and currents listed are nominal.

**electrical characteristics over recommended operating free-air temperature range,  $V_{CC} = 3.3\text{ V}$  (unless otherwise noted) (see Note 1)**

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{REF}$	Reference voltage	$I_{REF} = -1\text{ mA}$ , $T_A = 25^\circ\text{C}$	1.237	1.250	1.263	V
$V_{REF(dev)}$	Reference voltage change with $T_A$	$I_{REF} = -1\text{ mA}$ , See Note 2		15	25	mV
REGIN	Input regulation	$I_{REF} = -1\text{ mA}$ , $V_{CC} = 2.5\text{ V to }7\text{ V}$		2	5	mV
REGL	Output regulation	$I_{REF} = -0.1\text{ mA to }-1\text{ mA}$		1	5	mV
$I_{OS}$	Short-circuit output current	$V_{REF} = 0$	-2	-10	-30	mA

NOTES: 1. Typical values of all parameters except for  $V_{REF(dev)}$  and  $f_{dT}$  are specified at  $T_A = 25^\circ\text{C}$ .  
2. The deviation parameter  $V_{REF(dev)}$  is defined as the difference between the maximum and minimum values obtained over the recommended free-air temperature range ( $-20^\circ\text{C}$  to  $85^\circ\text{C}$ ).

### undervoltage lockout section

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{TH}$	Upper threshold voltage	$T_A = 25^\circ\text{C}$	2.2	2.3	2.4	V
$V_{TL}$	Lower threshold voltage	$T_A = 25^\circ\text{C}$	2	2.1	2.2	V
$V_{hys}$	Hysteresis ( $V_{TH} - V_{TL}$ )	$T_A = 25^\circ\text{C}$	0.1	0.2	0.3	V

NOTE 1: Typical values of all parameters except for  $V_{REF(dev)}$  and  $f_{dT}$  are specified at  $T_A = 25^\circ\text{C}$ .

### protection control section

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{SCP}$	Input terminal source current		-1.4	-2	-2.6	$\mu\text{A}$
$V_{T2}$	Input threshold voltage	CH-1, 3	1.10	1.15	1.20	V
$V_{T3}$		CH-2	0.20	0.25	0.30	
$V_R$	Latch reset threshold voltage	$T_A = 25^\circ\text{C}$	0.8	1.5		V
$V_{T5}$	Threshold voltage		1.20	1.25	1.30	V

NOTE 1: Typical values of all parameters except for  $V_{REF(dev)}$  and  $f_{dT}$  are specified at  $T_A = 25^\circ\text{C}$ .

### oscillator section

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$f_{OSC}$	Frequency	$C_T = 130\text{ pF}$ , $R_T = 7\text{ k}\Omega$	400	500	600	kHz
$f_{dV}$	Frequency change with $V_{CC}$	$V_{CC} = 2.5\text{ V}$ , $T_A = 25^\circ\text{C}$ , $C_T = 130\text{ pF}$ , $R_T = 7\text{ k}\Omega$		1%	2%	
$f_{dT}$	Frequency change with $T_A$	$C_T = 130\text{ pF}$ , $R_T = 7\text{ k}\Omega$		5%	10%	
$I_{CT/RT}$	Output source current		-180	-200	-220	$\mu\text{A}$
$V_{OSCH}$	H level output voltage		0.95	1	1.05	V
$V_{OSCL}$	L level output voltage		0.35	0.40	0.45	V

NOTE 1: Typical values of all parameters except for  $V_{REF(dev)}$  and  $f_{dT}$  are specified at  $T_A = 25^\circ\text{C}$ .

### dead time control section

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{BDT1/3}$	Input bias current	$V_{DTC1/3} = 0.35\text{ V to }1.05\text{ V}$			200	nA
$I_{BDT2}$		$V_{DTC2} = 0.35\text{ V to }1.05\text{ V}$		$\pm 2$	$\pm 20$	
$V_{T1}$	Comparator threshold voltage		0.2	0.25	0.3	V
$V_{T0(DTC1/3)}$	Input threshold voltage (DTC1/3) (see Note 3)	Duty = 0%	0.3	0.4	0.5	V
$V_{T100(DTC1/3)}$		Duty = 100%				
$V_{T0(DTC2)}$	Input threshold voltage (DTC2) (see Note 3)	Duty = 0%	0.3	0.4	0.5	V
$V_{T100(DTC2)}$		Duty = 100%				

NOTES: 1. Typical values of all parameters except for  $V_{REF(dev)}$  and  $f_{dT}$  are specified at  $T_A = 25^\circ\text{C}$ .  
3. These specifications are not production tested. They are specified as ensured values on circuit design.

# TPS5100

## TRIPLE-CHANNEL PWM CONTROL CIRCUITS

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electrical characteristics over recommended operating free-air temperature range,  $V_{CC} = 3.3\text{ V}$  (unless otherwise noted) (see Note 1) (continued)

### error amplifier section

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{IO}$	Input offset voltage	CH1, 3,	$A_V = 1$			15	mV
$I_{IB}$	Input bias current	CH1, 3,	$V_I = -.95\text{ V to }1.55\text{ V}$		$\pm 10$	$\pm 20$	nA
		CH2,	$V_I = 0.4\text{ V to }1\text{ V}$		$\pm 10$	$\pm 20$	
$V_{IR}$	Input voltage range	CH1, 3,		0.95		1.55	V
		CH2		0.4		1	
$A_{VD}$	Open-loop voltage amplification	$R_{FB} = 200\text{ k}\Omega$			60		dB
$B_1$	Unity-gain bandwidth				1		MHz
$V_{OM+}$	Output voltage swing	$V_{ID} = 0.1\text{ V}$	$I_O = 60\text{ }\mu\text{A}$	1.2			V
$V_{OM-}$			$I_O = 0.2\text{ mA}$	0.2			
$I_{OM+}$	Output sink current	$V_{ID} = 0.1\text{ V}$ ,	$V_O = 0.2\text{ V}$	0.2	1		mA
$I_{OM-}$	Output source current	$V_{ID} = 0.1\text{ V}$ ,	$V_O = 1.2\text{ V}$	-60	-100		$\mu\text{A}$
$V_{T4}$	Input bias voltage	CH2,	$A_V = 1$ , $T_A = 25^\circ\text{C}$	678	700	722	mV
		CH2,	$A_V = 1$	665	700	735	

NOTE 1: Typical values of all parameters except for  $V_{REF(dev)}$  and  $f_{dT}$  are specified at  $T_A = 25^\circ\text{C}$ .

### output section

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$V_{OH}$	High-level output voltage	$I_O = 20\text{ mA (CH2)}$		2.9	3.05		V
		$I_O = -40\text{ mA (CH1, 3)}$		1.9	2.2	2.6	
$V_{OL}$	Low-level output voltage	$I_O = 20\text{ mA (CH1, 3)}$			0.2	0.4	V
		$I_O = 40\text{ mA (CH2)}$		0.2	0.3	0.6	
$t_r$	Rise time	$CL = 1000\text{ pF}$			130		ns
$t_f$	Fall time	$I_O = 1000\text{ pF}$			50		ns

NOTE 1: Typical values of all parameters except for  $V_{REF(dev)}$  and  $f_{dT}$  are specified at  $T_A = 25^\circ\text{C}$ .

### total device

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$I_{CC}$	Supply current	Output OFF state			2.5	4	mA
$I_{CCA}$	Average supply current	$F_{OSC} = 500\text{ kHz}$ , Duty = 50%, No load			3.5	5	mA

NOTE 1: Typical values of all parameters except for  $V_{REF(dev)}$  and  $f_{dT}$  are specified at  $T_A = 25^\circ\text{C}$ .



TYPICAL CHARACTERISTICS

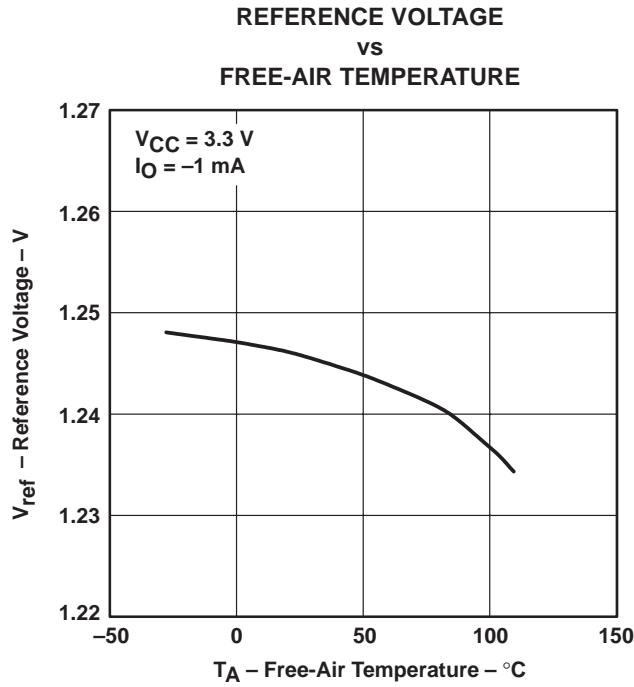


Figure 1

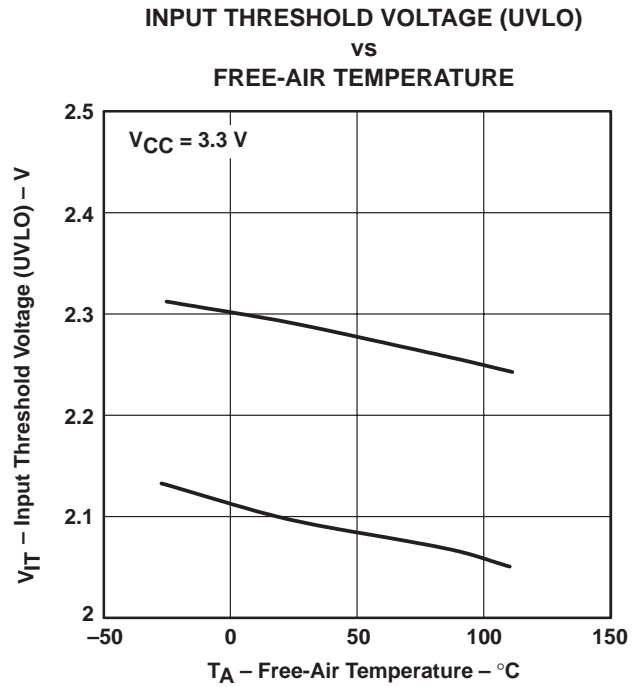


Figure 2

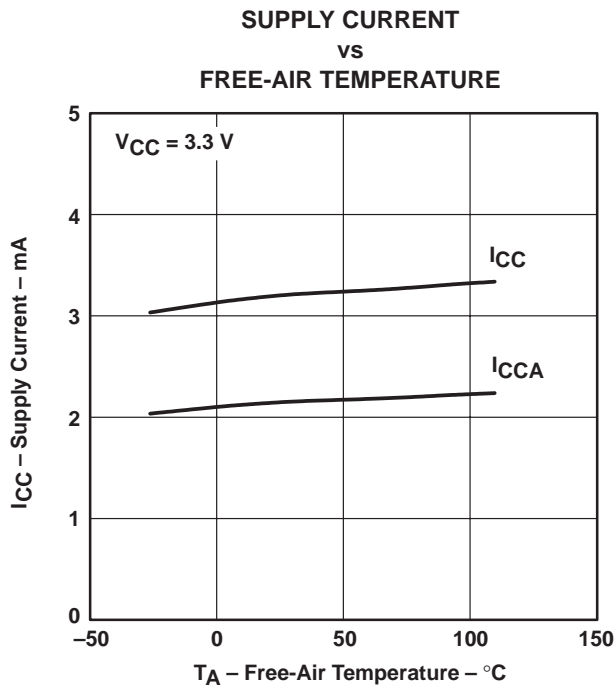


Figure 3

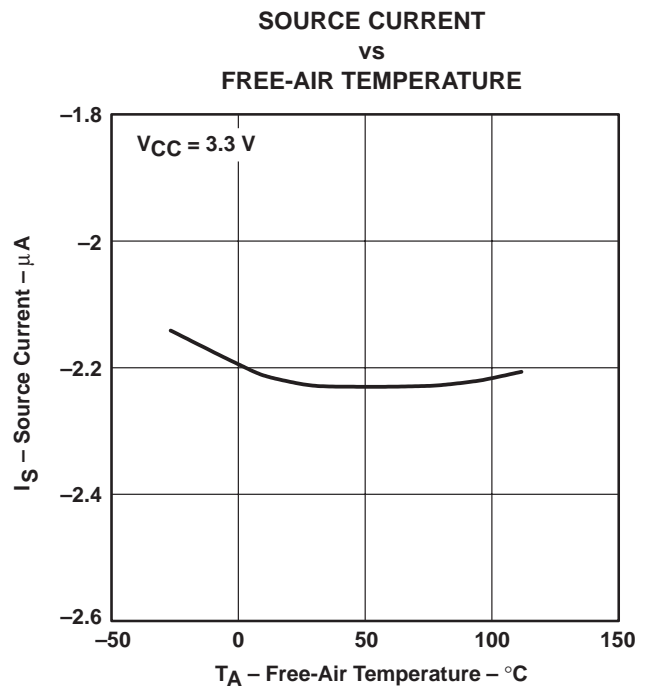


Figure 4

TYPICAL CHARACTERISTICS

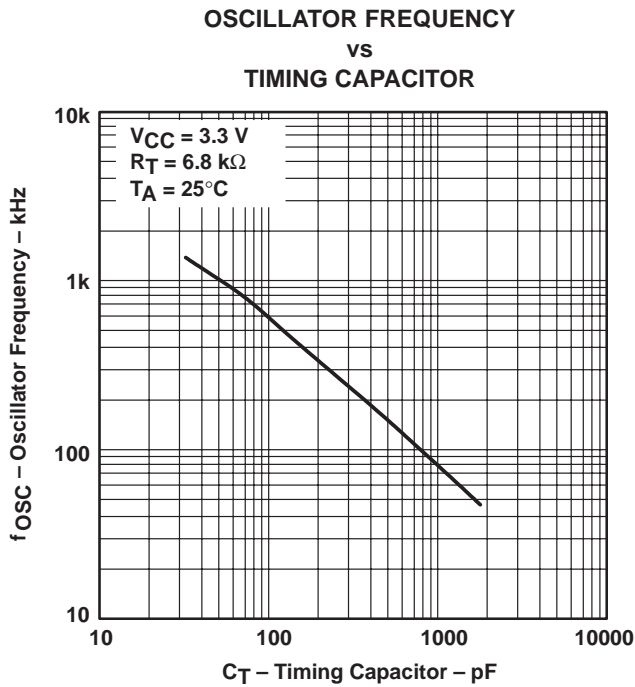


Figure 5

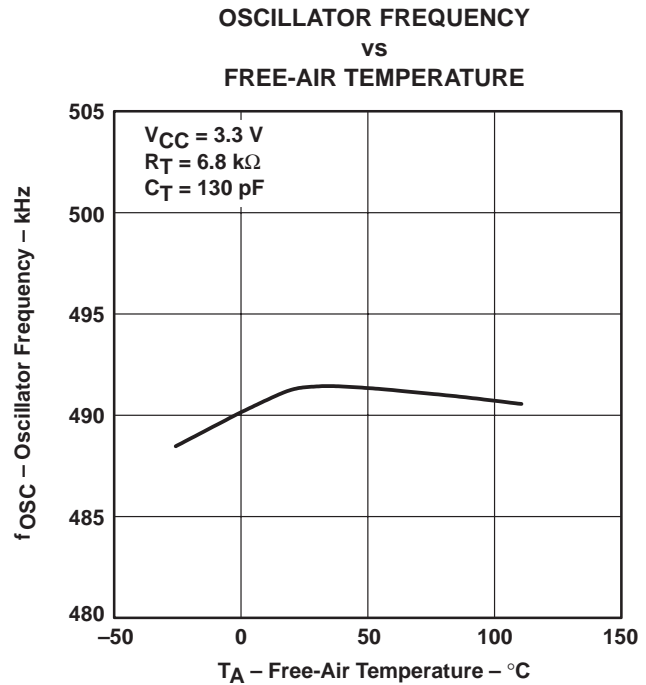


Figure 6

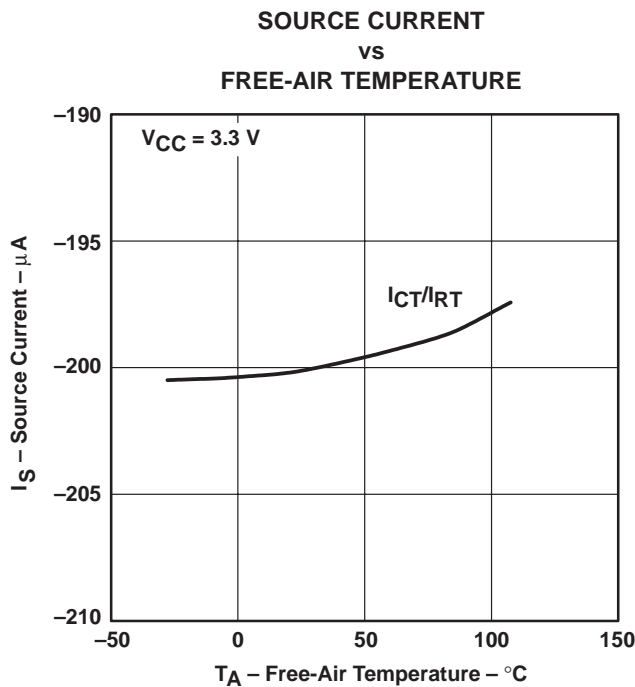


Figure 7

TYPICAL CHARACTERISTICS

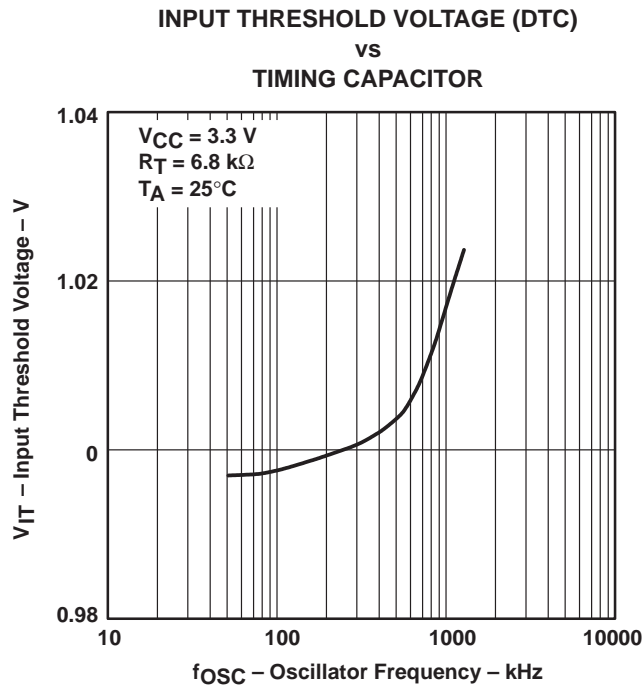


Figure 8

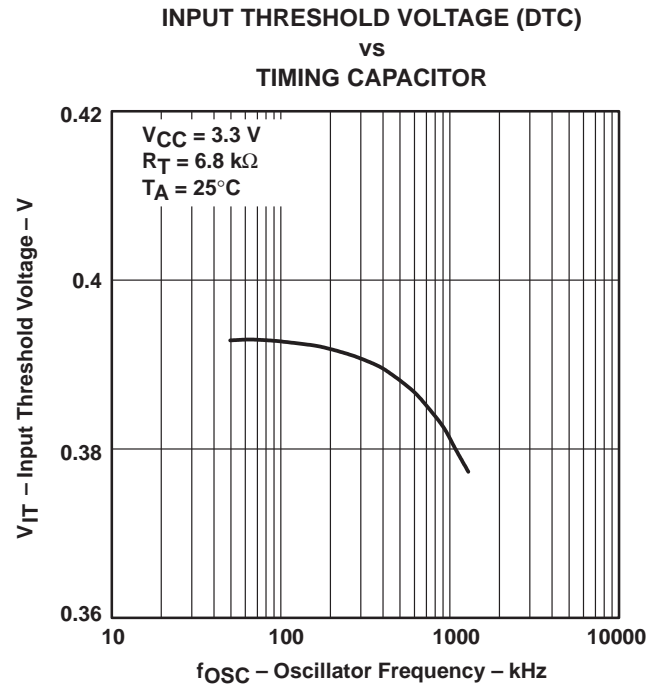


Figure 9

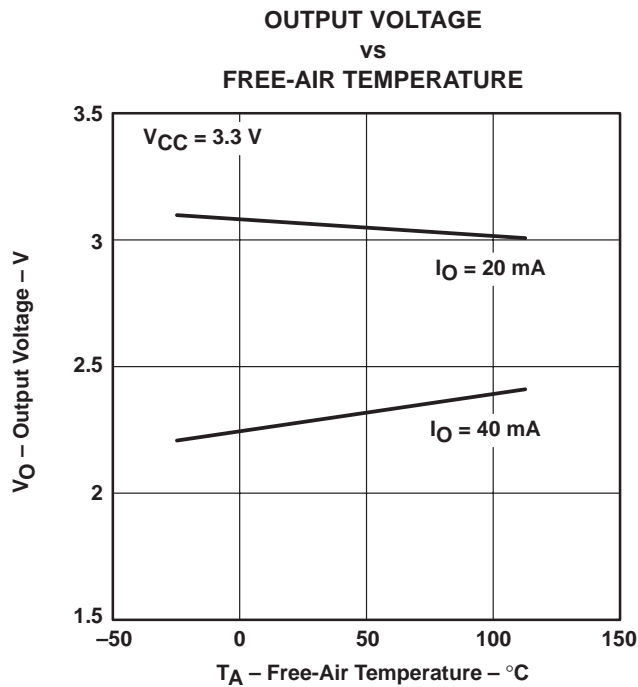


Figure 10

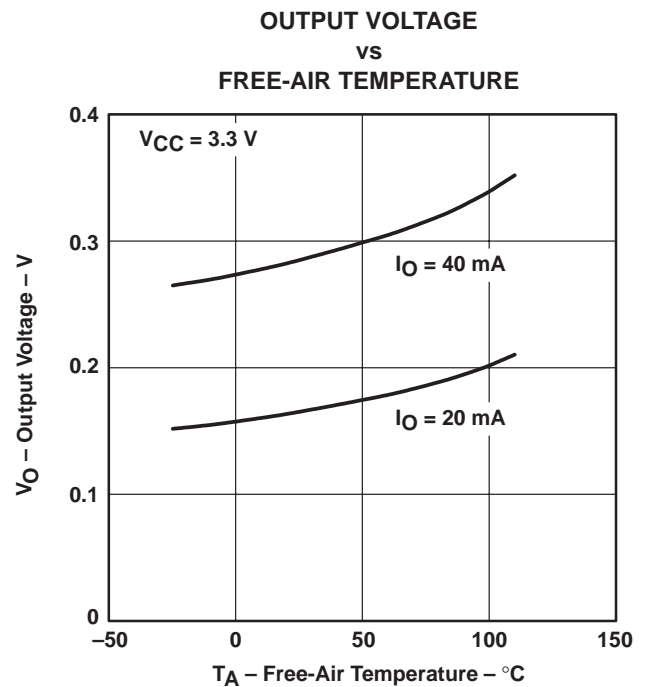
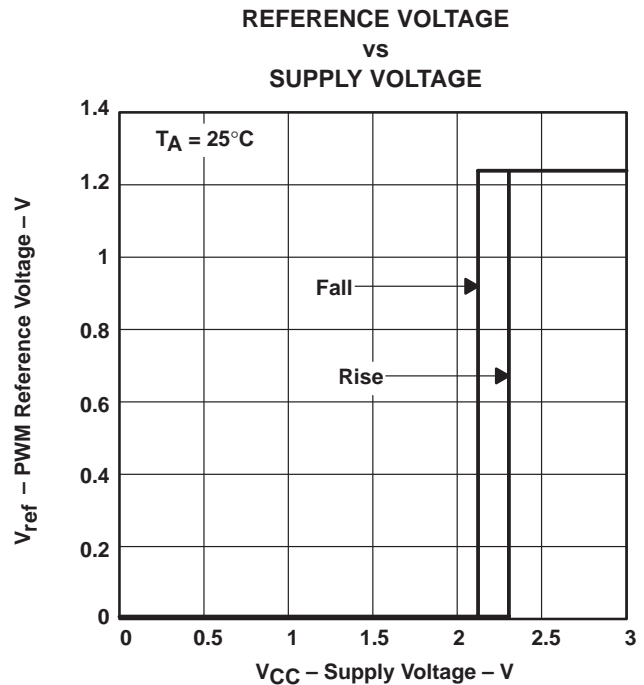
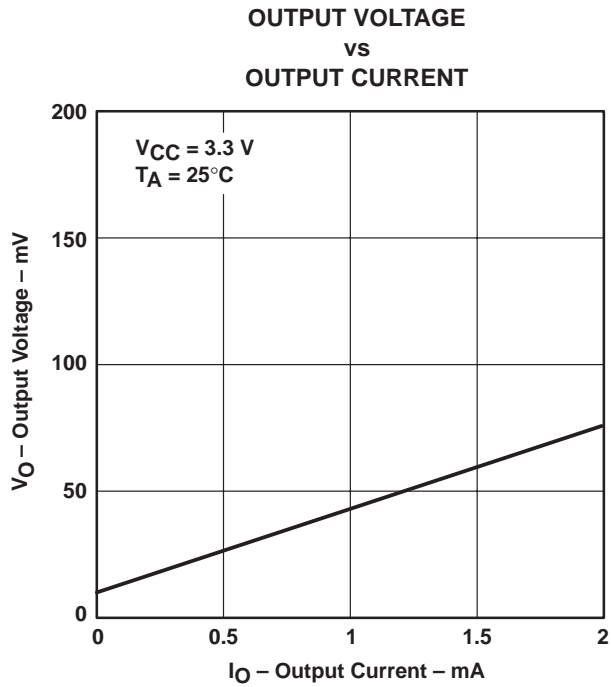
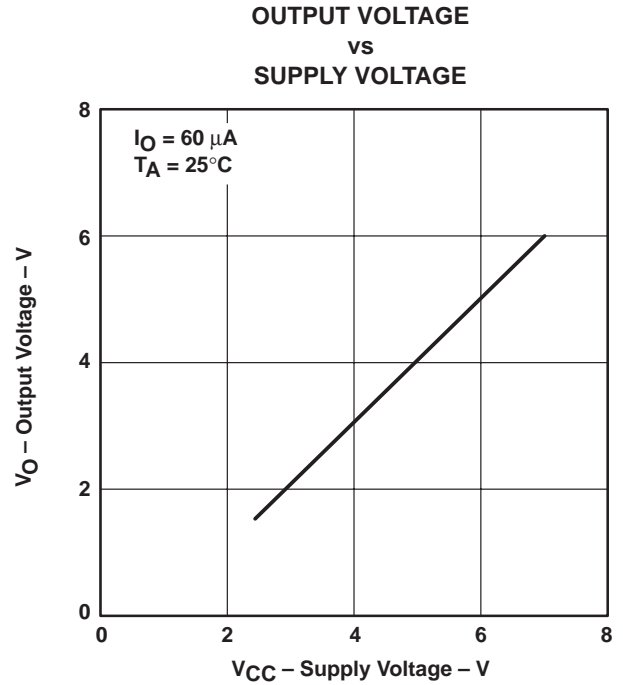
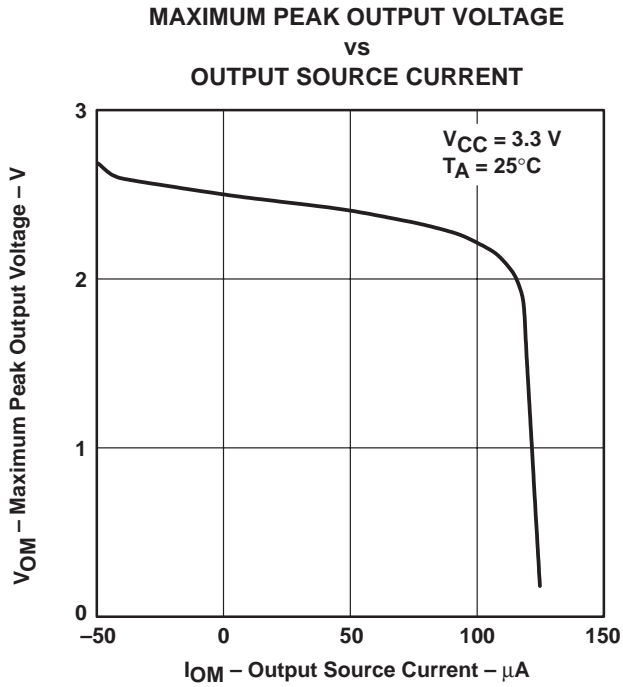


Figure 11

TYPICAL CHARACTERISTICS





TYPICAL CHARACTERISTICS

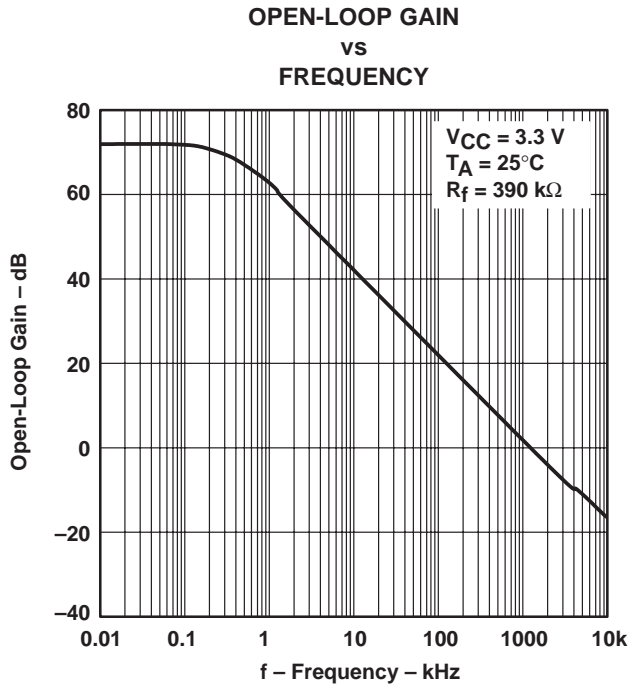


Figure 16

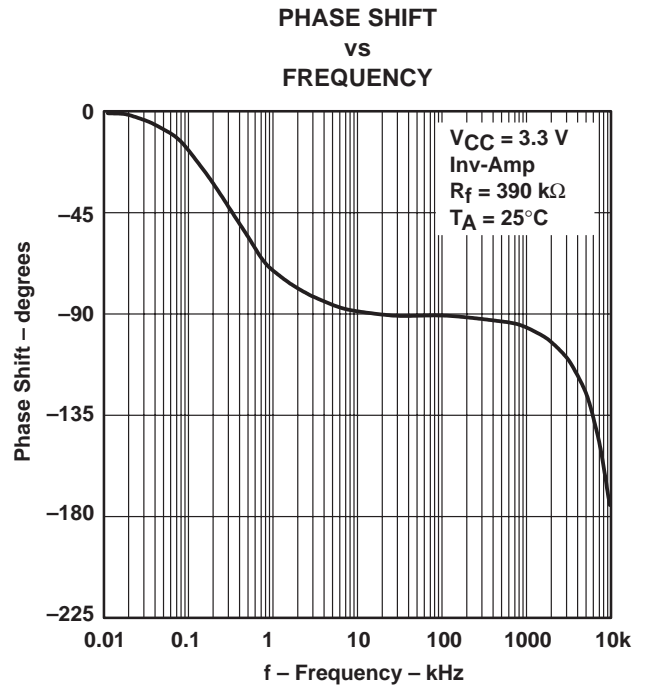


Figure 17

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS5100IPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	PU5100	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) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

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

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

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PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



4040064-4/G 02/11

- 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. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
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