

PT6930 Series

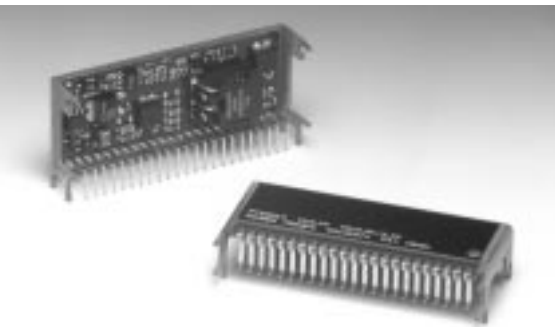
25 Watt 5V Input Dual Output
Integrated Switching Regulator

Power Trends Products
from Texas Instruments



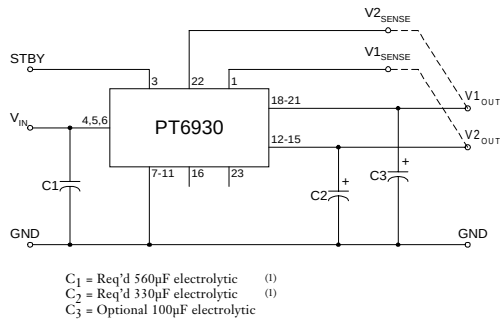
SLTS062A

(Revised 6/30/2000)



Patent pending on package assembly

Standard Application



- Dual Outputs:
+3.3V/2.5V
+3.3V/1.5V
+3.3V/1.8V
- Adjustable Output Voltage
- Remote Sense (both outputs)
- Standby Function
- Over-Temperature Protection
- Soft-Start
- Internal Sequencing
- 23-pin Excalibur™ Package

The PT6930 is a new series of 25W dual output ISRs designed to power the latest generation DSP chips. Both output voltages are independently adjustable with external resistors. In addition, the second output voltage of the PT6931 can be selected for either 2.5V or 1.8V to accommodate the next generation of DSP chips. The internal power sequencing of both outputs meet the requirements of TI's C6000 series DSPs.

Pin-Out Information

Pin	Function	Pin	Function
1	V ₁ Remote Sense	13	V ₁ out
2	Do Not Connect	14	V ₁ out
3	STBY	15	V ₁ out
4	V _{in}	16	V ₁ Adjust
5	V _{in}	17	Do Not Connect
6	V _{in}	18	V ₂ out
7	GND	19	V ₂ out
8	GND	20	V ₂ out
9	GND	21	V ₂ out
10	GND	22	V ₂ Remote Sense
11	GND	23	V ₂ Adjust*
12	V ₁ out		

*Note: V₁out and V₂out are adjustable, and can be pin-strapped to produce at least one alternative common bus voltage. Consult the factory for more information.

Ordering Information

PT6931□ = +3.3 Volts
+2.5/1.8 Volts
PT6932□ = +3.3 Volts
+1.5/1.2 Volts
PT6933□ = +3.3 Volts
+1.8/1.2 Volts

PT Series Suffix (PT1234X)

Case/Pin
Configuration

Vertical Through-Hole **N**
Horizontal Through-Hole **A**
Horizontal Surface Mount **C**

(For dimensions and PC board layout, see Package Styles 1320 and 1330.)

Specifications

Characteristics (T _a = 25°C unless noted)	Symbols	Conditions	PT6930 SERIES			Units
			Min	Typ	Max	
Output Current	I _o	T _a = +60°C, 200 LFM, pkg N V ₁ = 3.3V V ₂ = 2.5V V ₂ = 1.8V V ₂ = 1.5V V ₂ = 1.2V T _a = +25°C, natural convection V ₁ = 3.3V V ₂ = 2.5V V ₂ = 1.8V V ₂ = 1.5V V ₂ = 1.2V	0.1 (2) 0 0 0 0 0.1 0 0 0 0	— — — — — — — — — —	5.5 (3) 2.2 (3) 1.75 (3) 1.45 (3) 1.2 (3) 6.0 2.2 1.75 1.45 1.2	A A
Input Voltage Range	V _{in}	0.1A ≤ I _o ≤ I _{max}	4.5	—	5.5	V
Output Voltage Tolerance	ΔV _o	V _{in} = +5V, I _o = I _{max} , both outputs 0°C ≤ T _a ≤ +65°C	V _o -0.1	—	V _o +0.1	V
Line Regulation	Reg _{line}	4.5V ≤ V _{in} ≤ 5.5V, I _o = I _{max} V ₁ = 3.3V V ₂ = 2.5V	— —	±7 ±7	±17 ±13	V
Load Regulation	Reg _{load}	V _{in} = +5V, 0.1 ≤ I _o ≤ I _{max} V ₁ = 3.3V V ₂ = 2.5V	— —	±17 ±4	±33 ±10	mV
V _o Ripple/Noise	V _n	V _{in} = +5V, I _o = I _{max} V ₁ = 3.3V V ₂ = 2.5V	— —	50 25	— —	mV
Transient Response with C ₂ = 330µF	t _{tr} V _{os}	I _o step between 0.5I _{max} and I _{max} V _o over/undershoot V ₁ = 3.3V V ₂ = 2.5V	— — —	25 60 60	— — —	µSec mV
Efficiency	η	V _{in} = +5V, I _o = 4A total	—	75	—	%
Switching Frequency	f _o	4.5V ≤ V _{in} ≤ 5.5V 0.1A ≤ I _o ≤ I _{max}	475	600	725	kHz
Absolute Maximum Operating Temperature Range	T _a	—	-40 (4)	—	+85 (5)	°C
Storage Temperature	T _s	—	-40	—	+125	°C
Weight	—	Vertical/Horizontal	—	29	—	grams

Notes: (1) The PT6930 series requires a 560µF electrolytic capacitor on the input and a 330µF electrolytic capacitor on the output for proper operation in all applications.

(2) I_{min} current of 0.1A can be divided between both outputs; V₁, or V₂. The ISR will operate down to no-load with reduced specifications.

(3) I_{max} listed for each output assumes the maximum current drawn simultaneously on both outputs. Consult the factory for the absolute maximum.

(4) For operating temperatures below 0°C, use tantalum type capacitors on both the input and output.

(5) See Safe Operating Area curves for appropriate derating.

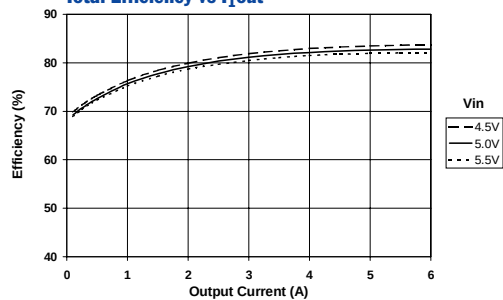
PT6930 Series

Typical Characteristics

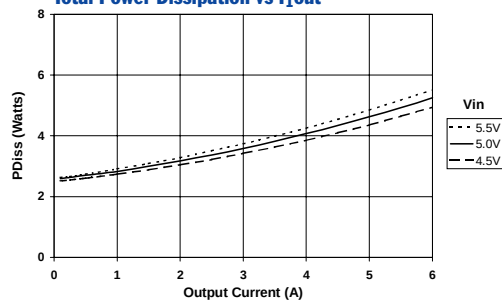
25 Watt 5V Input Dual Output
Integrated Switching Regulator

PT6931, $V_{2out} = 2.5V$, $I_{2out} = 2.2A$ (See Note A)

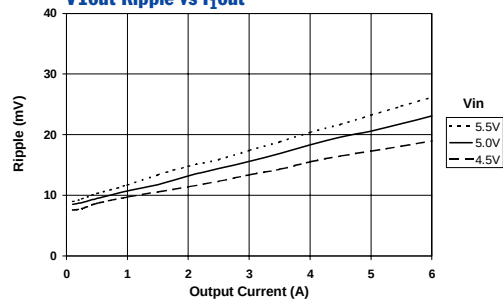
Total Efficiency vs I_{1out}



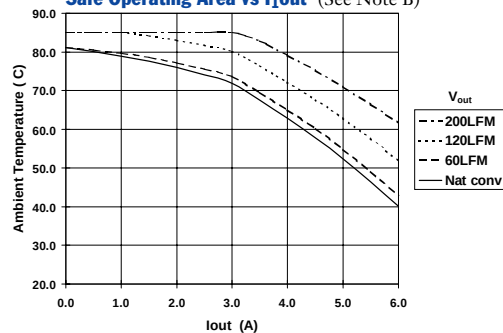
Total Power Dissipation vs I_{1out}



V_{1out} Ripple vs I_{1out}



Safe Operating Area vs I_{1out} (See Note B)



Note A: All characteristic data in the above graphs has been developed from actual products tested at 25°C. This data is considered typical data for the ISR.

Note B: SOA curves represent operating conditions at which internal components are at or below the manufacturer's maximum rated operating temperatures.

PT6920/PT6930 Series

Adjusting the Output Voltage of the PT6920 and PT6930 Dual Output Voltage ISRs

Each output voltage from the PT6920 and PT6930 series of ISRs can be independantly adjusted higher or lower than the factory trimmed pre-set voltage. V_1 (the voltage at V_1 out), or V_2 (the voltage at V_2 out) may each be adjusted either up or down using a single external resistor ². Table 1 gives the adjustment range for both V_1 and V_2 for each model in the series as V_a (min) and V_a (max). Note that V_2 must always be lower than V_1 ³.

V_1 Adjust Up: To increase the output, add a resistor R_4 between pin 16 (V_1 Adjust) and pins 7-11 (GND) ².

V_1 Adjust Down: Add a resistor (R_3), between pin 16 (V_1 Adjust) and pin 1 (V_1 Remote Sense) ².

V_2 Adjust Up: Add a resistor R_2 between pin 23 (V_2 Adjust) and pins 7-11 (GND) ².

V_2 Adjust Down: Add a resistor (R_1) between pin 23 (V_2 Adjust) and pin 22 (V_2 Remote Sense) ².

Refer to Figure 1 and Table 2 for both the placement and value of the required resistor.

Notes:

1. The output voltages, V_1 out and V_2 out, may be adjusted independantly.
2. Use only a single 1% resistor in either the (R_3) or R_4 location to adjust V_1 , and in the (R_1) or R_2 location to adjust V_2 . Place the resistor as close to the ISR as possible.
3. V_2 must always be at least 0.2V lower than V_1 .
4. V_2 on both the PT6921 and PT6931 models may be adjusted from 2.5V to 1.8V by simply connecting pin 22 (V_2 Remote Sense) to pin 23 (V_2 Adjust). For more details, consult the data sheet.

5. If V_1 is increased above 3.3V, the minimum input voltage to the ISR must also be increased. The minimum required input voltage must be $(V_1 + 1.2)V$ or 4.5V, whichever is greater. Do not exceed 5.5V
6. Never connect capacitors to either the V_1 Adjust or V_2 Adjust pins. Any capacitance added to these control pins will affect the stability of the respective regulated output.
7. Adjusting either voltage (V_1 or V_2) may increase the power dissipation in the regulator, and correspondingly change the maximum current available at either output. Consult the factory for application assistance.

The adjust up and adjust down resistor values can also be calculated using the following formulas. Be sure to select the correct formula parameter from Table 1 for the output and model being adjusted.

$$(R1) \text{ or } (R3) = \frac{R_o (V_a - 1)}{V_o - V_a} - R_s \quad k\Omega$$

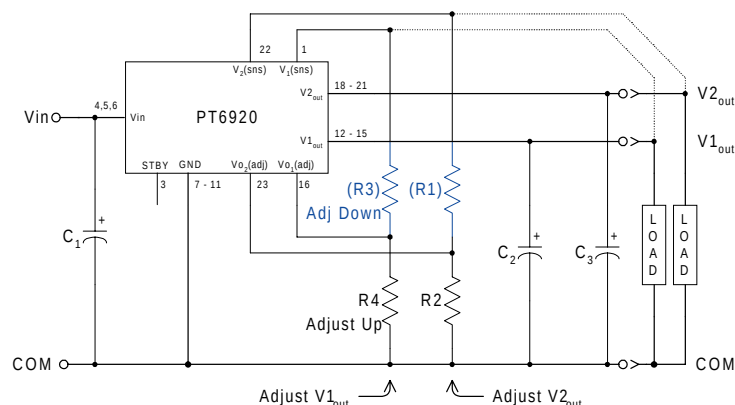
$$R2 \text{ or } R4 = \frac{R_o}{V_a - V_o} - R_s \quad k\Omega$$

Where: V_o = Original output voltage, (V_1 or V_2)
 V_a = Adjusted output voltage
 R_o = The resistance value from Table 1
 R_s = The series resistance from Table 1

Table 1

PT6920 ADJUSTMENT RANGE AND FORMULA PARAMETERS			
Output Bus	V_1 out	V_2 out	
Series Pt #			
Standard Case	PT6921/22	PT6921	PT6922
Excalibur Case	PT6931/32	PT6931	PT6932
Adj. Resistor	(R_3)/ R_4	(R_1)/ R_2	(R_1)/ R_2
V_o (nom)	3.3V	2.5V	1.5
V_a (min)	2.3V	1.8V	1.2
V_a (max)	3.6V	3.0V	3.0
R_o (k Ω)	12.1	10.0	9.76
R_s (k Ω)	12.1	11.5	6.49

Figure 1



Application Notes *continued*

PT6920/PT6930 Series

Table 2

PT6920/PT6930 ADJUSTMENT RESISTOR VALUES

Output Bus	V _{1out}	V _{2out}	
Series Pt#			
Standard Case	PT6921/6922	PT6921	PT6922
Excalibur Case	PT6931/6932	PT6931	PT6932
Adj Resistor	(R3)/R4	(R1)/R2	(R1)/R2
V ₀ (nom)	3.3Vdc	2.5Vdc	1.5Vdc
V _A (req'd)			
1.2			(0.0)kΩ
1.25			(3.3)kΩ
1.3			(8.2)kΩ
1.35			(16.3)kΩ
1.4			(32.6)kΩ
1.45			(81.4)kΩ
1.5			
1.55			189.0kΩ
1.6			91.1kΩ
1.65			58.6kΩ
1.7			42.3kΩ
1.75			32.6kΩ
1.8		(0.0)kΩ	26.0kΩ
1.85		(1.6)kΩ	21.4kΩ
1.9		(3.5)kΩ	17.9kΩ
1.95		(5.8)kΩ	15.2kΩ
2.0		(8.5)kΩ	13.0kΩ
2.05		(11.8)kΩ	11.3kΩ
2.1		(16.0)kΩ	9.8kΩ
2.15		(21.4)kΩ	8.5kΩ
2.2		(28.5)kΩ	7.5kΩ
2.25		(38.5)kΩ	6.5kΩ
2.3	(3.6)kΩ	(53.5)kΩ	5.7kΩ
2.35	(5.1)kΩ	(78.5)kΩ	5.0kΩ
2.4	(6.7)kΩ	(129.0)kΩ	4.4kΩ
2.45	(8.5)kΩ	(279.0)kΩ	3.8kΩ
2.5	(10.6)kΩ		3.3kΩ
2.55	(12.9)kΩ	189.0kΩ	2.8kΩ
2.6	(15.6)kΩ	88.5kΩ	2.4kΩ
2.65	(18.6)kΩ	55.2kΩ	2.0kΩ
2.7	(22.2)kΩ See Note 3	38.5kΩ	1.6kΩ
2.75	(26.4)kΩ	28.5kΩ	1.3kΩ
2.8	(31.5)kΩ	21.8kΩ	1.0kΩ
2.85	(37.6)kΩ	17.1kΩ	0.7kΩ
2.9	(45.4)kΩ	13.5kΩ	0.5kΩ
2.95	(55.3)kΩ	10.7kΩ	0.2kΩ
3.0	(68.6)kΩ	8.5kΩ	0.0kΩ
3.05	(87.1)kΩ		
3.1	(115.0)kΩ		
3.15	(161.0)kΩ		
3.2	(254.0)kΩ		
3.25	(532.0)kΩ		
3.3			
3.4	109.0kΩ See Note 5		
3.5	48.4kΩ		
3.6	28.2kΩ		

R1/R3 = (Blue) R2/R4 = Black

PT6920/PT6930 Series

Using the Standby Function on the PT6920 and PT6930 Dual Output Voltage Converters

Both output voltages of the 23-pin PT6920/6930 dual output converter may be disabled using the regulator's standby function. This function may be used in applications that require power-up/shutdown sequencing, or wherever there is a requirement to control the output voltage On/Off status with external circuitry.

The standby function is provided by the *STBY** control, pin 3. If pin 3 is left open-circuit the regulator operates normally, and provides a regulated output at both V_1 out (pins 12–15) and V_2 out (pins 18–21) whenever a valid supply voltage is applied to V_{in} (pins 4, 5, & 6) with respect to GND (pins 7–11). If a low voltage² is then applied to pin-3 both regulator outputs will be simultaneously disabled and the input current drawn by the ISR will typically drop to less than 30mA (50mA max). The standby control may also be used to hold-off both regulator outputs during the period that input power is applied.

The standby pin is ideally controlled using an open-collector (or open-drain) discrete transistor (See Figure 1). It may also be driven directly from a dedicated TTL³ compatible gate. Table 1 provides details of the threshold requirements.

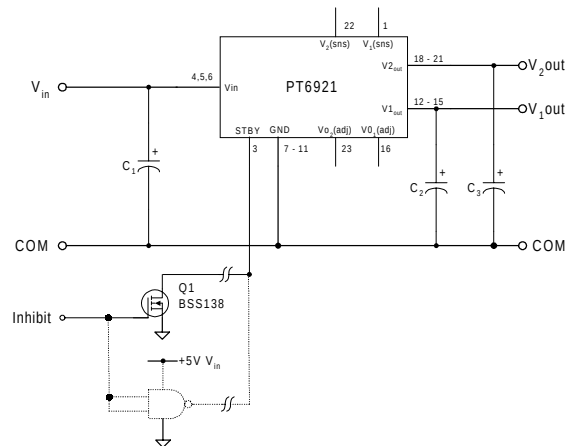
Table 1 Inhibit Control Thresholds^{2,3}

Parameter	Min	Max
Enable (V_{IH})	1.8V	V_{in}
Disable (V_{IL})	-0.1V	0.8V

Notes:

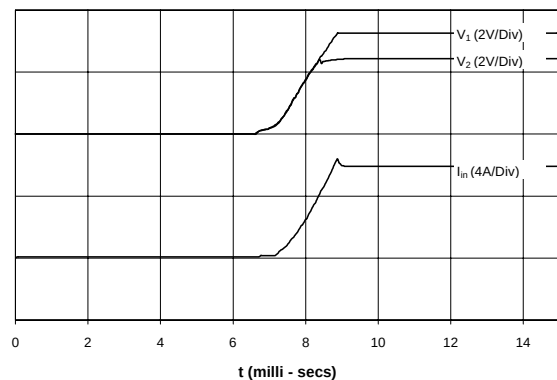
1. The Standby/Inhibit control logic is similar for all Power Trends' modules, but the flexibility and threshold tolerances will be different. For specific information on this function for other regulator models, consult the applicable application note.
2. The Standby control pin is ideally controlled using an open-collector (or open-drain) discrete transistor and requires no external pull-up resistor. To disable the regulator output, the control pin must be pulled to less than 0.8Vdc with a low-level 0.5mA sink to ground.
3. The Standby input on the PT6920/6930 series may be driven by a differential output device, making it directly compatible with TTL logic. The control input has an internal pull-up to the input voltage V_{in} . A voltage of 1.8V or greater ensures that the regulator is enabled. Do not use devices that can drive the Standby control input above 5.5V or V_{in} .

Figure 1



Turn-On Time: Turning Q_1 in Figure 1 off removes the low-voltage signal at pin 3 and enables both outputs from the PT6920/6930 regulator. Following a delay of about 5–10ms, V_1 out and V_2 out rise together until the lower voltage, V_2 out, reaches its set output. V_1 out then continues to rise until both outputs reach full regulation voltage. The total power-up time is less than 15ms, and is relatively independent of load, temperature, and output capacitance. Figure 2 shows waveforms of the input current I_{in} and output voltages V_1 out and V_2 out, for a PT6921 (3.3V/2.5V). The turn-off of Q_1 corresponds to $t = 0$ secs. The waveforms were measured with a 5Vdc input voltage, and with resistive loads of 5.5A and 2.2A at the V_1 out and V_2 out outputs respectively.

Figure 2



IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgment, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

Customers are responsible for their applications using TI components.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.