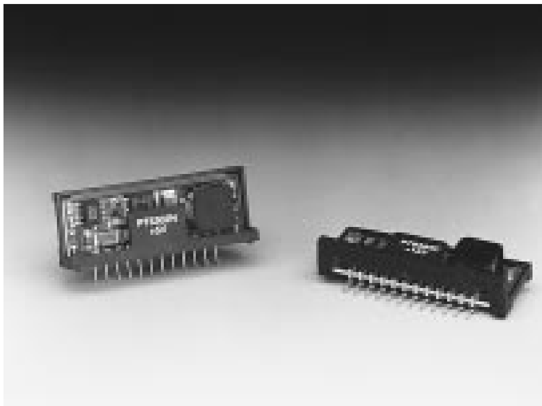
3 Amp Adjustable Positive Step-down Integrated Switching Regulators

SLTS031B

(Revised 9/30/2000)

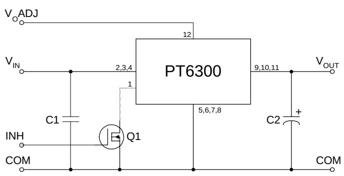


- 90% Efficiency
- Adjustable Output Voltage
- Internal Short Circuit Protection
- Over-Temperature Protection
- On/Off Control (Ground Off)
- Small SIP Footprint
- Wide Input Range

The PT6300 Series is a line of High-Performance 3 Amp, 12-Pin SIP (Single In-line Package) Integrated Switching Regulators (ISRs) designed to meet the on-board power conversion needs of battery powered or other equipment requiring high efficiency and small size. This high performance ISR family offers a unique combination of features combining 90% typical efficiency with open-collector on/off control and adjustable output voltage.

Quiescent current in the shutdown mode is typically less than 100µA.

Standard Application



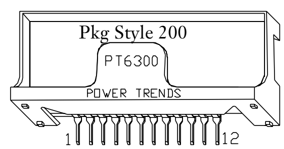
C_1 = Optional 1µF ceramic
C_2 = Required 100µF electrolytic (1)
Q_1 = NFET

Pin-Out Information

Pin	Function
1	Inhibit (30V max)
2	V_{in}
3	V_{in}
4	V_{in}
5	GND
6	GND
7	GND
8	GND
9	V_{out}
10	V_{out}
11	V_{out}
12	V_{out} Adj (5)

Ordering Information

PT6302☐ = +5 Volts
PT6303☐ = +3.3 Volts
PT6304☐ = +12 Volts
PT6314☐ = +1.5Volts



PT Series Suffix (PT1234X)

Case/Pin Configuration	
Vertical Through-Hole	N
Horizontal Through-Hole	A
Horizontal Surface Mount	C

Specifications

Characteristics (T_a=25°C unless noted)	Symbols	Conditions	PT6300 SERIES Min	Typ	Max	Units
Output Current	I_o	Over V_{in} range	0.1 (2)	—	3.0	A
Short Circuit Current	I_{sc}	$V_{in} = V_o + 5V$	—	5.0	—	Apk
Input Voltage Range *(Note: inhibit function cannot be used above 30V.)*	V_{in}	$0.1 \le I_o \le 3.0$ A; V_o = 12V V_o = 5.0V V_o = 3.3V V_o = 1.5V	16 9 9 9.0	— — — —	30/38 (3) 30/38 (3) 26 17	V
Output Voltage Tolerance	ΔV_o	Over V_{in} Range, I_o = 3.0 A T_a = 0°C to +60°C	—	±1.0	±2.0	$\%V_o$
Line Regulation	Reg_{line}	Over V_{in} range	—	±0.25	±0.5	$\%V_o$
Load Regulation	Reg_{load}	$0.1 \le I_o \le 3.0$ A	—	±0.25	±0.5	$\%V_o$
V_o Ripple/Noise	V_n	$V_{in} = V_{in}$ min, I_o = 3.0 A	—	±2	—	$\%V_o$
Transient Response with C_o = 100µF	t_{tr} V_{os}	50% load change V_o over/undershoot	— —	100 5.0	200 —	µSec $\%V_o$
Efficiency	η	V_{in}=16V, I_o = 0.5 A, V_o = 12V V_{in}=9V, I_o = 0.5 A, V_o = 5.0V V_{in}=9V, I_o = 0.5 A, V_o = 3.3V V_{in}=9V, I_o =0.5A, V_o = 1.5V	— — — —	91 89 84 72	— — — —	%
Switching Frequency	f_o	Over V_{in} and I_o ranges, V_o = 12V V_o = 3.3V/5V V_o = 1.5V	600 400 350	750 500 450	900 600 550	kHz
Shutdown Current	I_{sc}	V_{in} = 15V	—	100	—	µA
Quiescent Current	I_{nl}	I_o = 0A, V_{in} =10V	—	10	—	mA
Absolute Maximum Operating Temperature Range	T_a	Over V_{in} range	-40	—	+85 (4)	°C
Thermal Resistance	θ_{ja}	Free Air Convection (40-60LFM)	—	30	—	°C/W
Storage Temperature	T_s	—	-40	—	+125	°C
Mechanical Shock		Per Mil-STD-883D, Method 2002.3, 1 msec, Half Sine, mounted to a fixture	—	500	—	G's
Mechanical Vibration		Per Mil-STD-883D, Method 2007.2, 20-2000 Hz,Soldered in a PC board	—	10	—	G's
Weight	—	—	—	6.5	—	grams

Notes: *(1) The PT6300 Series requires a 100µF electrolytic or tantalum output capacitor for proper operation in all applications.*
(2) The ISR will operate to no load with reduced specifications.
(3) Input voltage cannot exceed 30V when the inhibit function is used.
(4) See Thermal Derating charts.
(5) Consult the related application note for guidance on adjusting the output voltage.

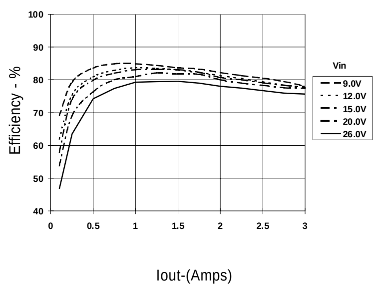
Typical Characteristics

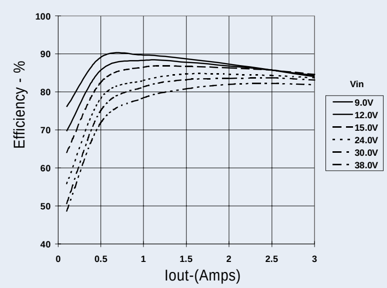
PT6303, 3.3 VDC (See Note A)

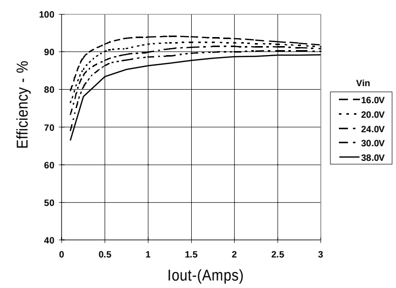
PT6302, 5.0 VDC (See Note A)

PT6304, 12.0 VDC (See Note A)

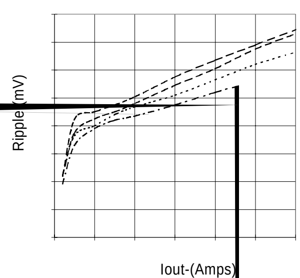
Efficiency vs Output Current







Ripple vs Output Current



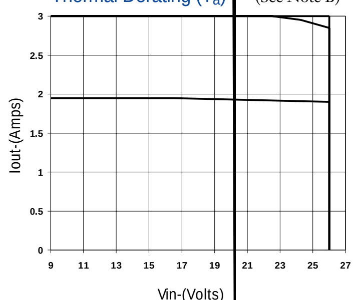
Ripple-(mV)

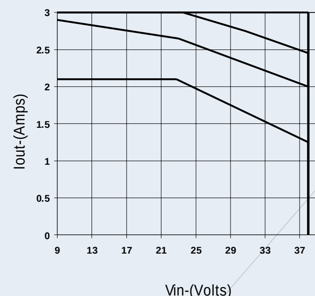
Iout-(Amps)

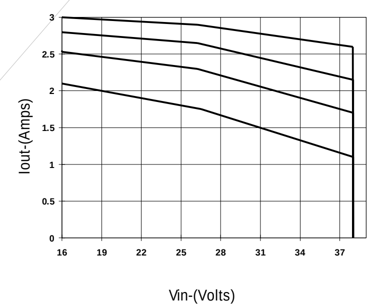
Ripple-(mV)

Iout-(Amps)

Thermal Derating (T_a) (See Note B)







Power Dissipation vs Output Current

PD-(Watts)

Iout-(Amps)

PD-(Watts)

Iout-(Amps)

PD-(Watts)

4.5 4 3.5 3 2.5 2 1.5 1 0.5 0

53 . 522 . 511 . 00

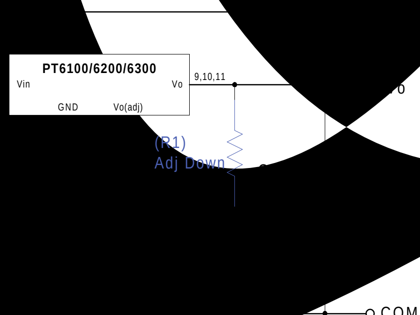
Iout-(Amps)

[redacted]Ou[redacted]
[redacted]ang[redacted]

[redacted]age [redacted]Rs m[redacted]ned p[redacted]sistor.[redacted]nent ra[redacted] and V_a [redacted]

[redacted]ncrease in[redacted] between p[redacted]

[redacted]esistor (R1), [redacted]



[redacted] The values of (R1) [adjust down], and R2 [adjust up], can also be calculated using the following formulas. Refer to Figure 1 and Table 2 for both the placement and value of the required resistor; either (R1) or R2 as appropriate.

$$(R1) = \frac{R_o (V_a - 1.25)}{V_o - V_a} \quad k\Omega$$

$$R2 = \frac{1.25\, R_o}{V_a - V_o} \quad k\Omega$$

Where: V_o = Original output voltage

[redacted]utput voltage

[redacted]stance value from Table 1

[redacted] AND FORMULA PARAMETERS					
[redacted]		PT6102	PT6101		PT6103
[redacted]	[redacted]T6216	PT6213		PT6212	PT6214
[redacted]	PT6314	PT6303		PT6302	PT6304
[redacted]	1.5	3.3	5.0	5.0	12.0
[redacted]n)	1.3	1.8	1.88	2.18	2.43
[redacted]a (max)	1.9	6.07	11.25	8.5	22.12
R_o (kΩ)	8.25	66.5	150.0	90.9	243.0

Notes:

1. Use only a single 1% resistor in ei[redacted] (R1) location. Place the resistor as cl[redacted]
2. Never connect capacitors fro[redacted] or V_{out}. Any capacitance a[redacted] affect the stability of the [redacted]
3. Adjustments to the ou[redacted] limits on the maxim[redacted] the part. The re[redacted] voltage limits m[redacted] requirements[redacted]

PT6216/[redacted]

V_{in} [redacted]s le[redacted]

[redacted] or as specified.

[redacted]a + 4V [redacted]9V, whichever is greater.

Table 2

ISR ADJUSTMENT RESISTOR VALUES

1Adc Rated		PT6102	PT6101		PT6103
2Adc Rated	PT6216	PT6213		PT6212	PT6214
3Adc Rated	PT6314	PT6303		PT6302	PT6304
V_o (nom)	1.5	3.3	5.0	5.0	12.0
V_a (req.d)					
1.3	(2.1kΩ)				
1.4	(12.4kΩ)				
1.5					
1.6	103.0kΩ				
1.7	51.6kΩ				
1.8	34.4kΩ	(24.4)kΩ			
1.9	25.8kΩ	(30.9)kΩ	(31.5)kΩ		
2.0		(38.4)kΩ	(37.5)kΩ		
2.1		(47.1)kΩ	(44.0)kΩ		
2.2		(57.4)kΩ	(50.9)kΩ	(30.8)kΩ	
2.3		(69.8)kΩ	(58.3)kΩ	(35.4)kΩ	
2.4		(85.0)kΩ	(66.3)kΩ	(40.2)kΩ	
2.5		(104.0)kΩ	(75.0)kΩ	(45.5)kΩ	(32.0)kΩ
2.6		(128.0)kΩ	(84.4)kΩ	(51.1)kΩ	(34.9)kΩ
2.7		(161.0)kΩ	(94.6)kΩ	(57.3)kΩ	(37.9)kΩ
2.8		(206.0)kΩ	(106.0)kΩ	(64.0)kΩ	(40.9)kΩ
2.9		(274.0kΩ	(118.0)kΩ	(71.4)kΩ	(44.1)kΩ
3.0		(388.0)kΩ	(131.0)kΩ	(79.5)kΩ	(47.3)kΩ
3.1		(615.0)kΩ	(146.0)kΩ	(88.5)kΩ	(50.5)kΩ
3.2		(1300.0)kΩ	(163.0)kΩ	(98.5)kΩ	(53.8)kΩ
3.3		(181.0)kΩ	(110.0)kΩ	(57.3)kΩ	
3.4		831.0kΩ	(202.0)kΩ	(122.0)kΩ	(60.8)kΩ
3.5		416.0kΩ	(225.0)kΩ	(136.0)kΩ	(64.3)kΩ
3.6		227.0kΩ	(252.0)kΩ	(153.0)kΩ	(68.0)kΩ
3.7		208.0kΩ	(283.0)kΩ	(171.0)kΩ	(71.7)kΩ
3.8		166.0kΩ	(319.0)kΩ	(193.0)kΩ	(75.6)kΩ
3.9		139.0kΩ	(361.0)kΩ	(219.0)kΩ	(79.5)kΩ
4.0		119.0kΩ	(413.0)kΩ	(250.0)kΩ	(83.5)kΩ
4.1		104.0kΩ	(475.0)kΩ	(288.0)kΩ	(87.7)kΩ
4.2		92.4kΩ	(533.0)kΩ	(335.0)kΩ	(91.9)kΩ
4.3		83.1kΩ	(654.0)kΩ	(396.0)kΩ	(96.3)kΩ
4.4		75.6kΩ	(788.0)kΩ	(477.0)kΩ	(101.0)kΩ
4.5		69.3kΩ	(975.0)kΩ	(591.0)kΩ	(105.0)kΩ
4.6		63.9kΩ	(1260.0)kΩ	(761.0)kΩ	(110.0)kΩ
4.7		59.4kΩ	(1730.0)kΩ	(1050.0)kΩ	(115.0)kΩ
4.8		55.4kΩ		(1610.0)kΩ	(120.0)kΩ
4.9		52.0kΩ			(125.0)kΩ
5.0		48.9kΩ			(130.0)kΩ
5.1		46.2kΩ	1880.0kΩ	1140.0kΩ	(136.0)kΩ
5.2		43.8kΩ	937.0kΩ	568.0kΩ	(141.0)kΩ
5.3		41.6kΩ	625.0kΩ	379.0kΩ	(147.0)kΩ
5.4		39.6kΩ	469.0kΩ	284.0kΩ	(153.0)kΩ
5.5		37.8kΩ	375.0kΩ	227.0kΩ	(159.0)kΩ
5.6		36.1kΩ	313.0kΩ	189.0kΩ	(165.0)kΩ
5.7		34.6kΩ	268.0kΩ	162.0kΩ	(172.0)kΩ
5.8		33.3kΩ	234.0kΩ	142.0kΩ	(178.0)kΩ
5.9		32.0kΩ	208.0kΩ	126.0kΩ	(185.0)kΩ
6.0		30.8kΩ	188.0kΩ	114.0kΩ	(192.0)kΩ

ISR ADJUSTMENT RESISTOR VALUES (Cont)

1Adc Rated	PT6101		PT6103
2Adc Rated		PT6212	PT6214
3Adc Rated		PT6302	PT6304
V_o (nom)	5.0	5.0	12.0
V_a (req.d)			
6.2	156.0kΩ	94.7kΩ	(207.0)kΩ
6.4	134.0kΩ	81.2kΩ	(223.0)kΩ
6.6	117.0kΩ	71.0kΩ	(241.0)kΩ
6.8	104.0kΩ	63.1kΩ	(259.0)kΩ
7.0	93.8kΩ	56.8kΩ	(279.0)kΩ
7.2	85.2kΩ	51.6kΩ	(301.0)kΩ
7.4	78.1kΩ	47.3kΩ	(325.0)kΩ
7.6	72.1kΩ	43.7kΩ	(351.0)kΩ
7.8	67.0kΩ	40.6kΩ	(379.0)kΩ
8.0	62.5kΩ	37.9kΩ	(410.0)kΩ
8.2	58.6kΩ	35.5kΩ	(444.0)kΩ
8.4	55.1kΩ	33.4kΩ	(483.0)kΩ
8.6	52.1kΩ		(525.0)kΩ
8.8	49.3kΩ		(573.0)kΩ
9.0	46.9kΩ		(628.0)kΩ
9.5	41.7kΩ		(802.0)kΩ
10.0	37.5kΩ		(1060.0)kΩ
10.5	34.1kΩ		(1500.0)kΩ
11.0	31.3kΩ		
11.5			
12.0			
12.5			608.0kΩ
13.0			304.0kΩ
13.5			203.0kΩ
14.0			152.0kΩ
14.5			122.0kΩ
15.0			101.0kΩ
15.5			86.8kΩ
16.0			75.9kΩ
16.5			67.5kΩ
17.0			60.8kΩ
17.5			55.2kΩ
18.0			50.6kΩ
18.5			46.7kΩ
19.0			43.4kΩ
19.5			40.5kΩ
20.0			38.0kΩ
20.5			35.7kΩ
21.5			33.8kΩ
21.5			32.0kΩ
22.0			30.4kΩ

R1 = (Blue)   R2 = Black

[redacted] requ[redacted] roduc[redacted] uses [redacted] cing, [redacted] from [redacted] e On/O[redacted] trol.

[redacted] s normal[redacted] ted outp[redacted] o V_{in}, (pi[redacted] is applie[redacted] led.

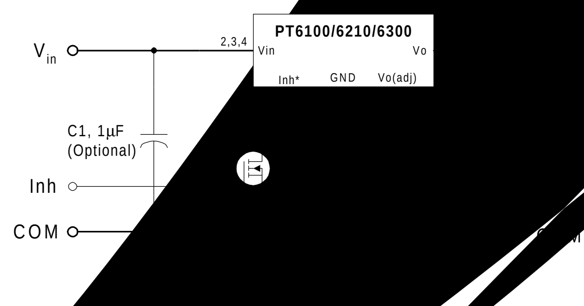
[redacted] lication sche[redacted] hibit function[redacted] ibit control has [redacted] open-circuit volt[redacted] en-collector or o[redacted] this pin. A discret[redacted] polar [redacted] mended.

[redacted]

Notes:

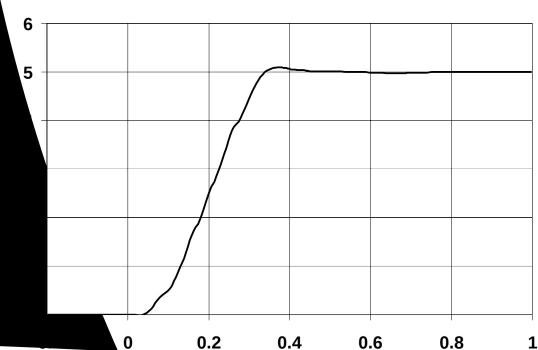
1. The Inhibit control logic is similar for all Power Trends' modules, but the flexibility and threshold tolerances will b[redacted] different. For specific information on the inhibit functi[redacted] of other ISR models, consult the applicable applicati[redacted] note.
2. Use only a true open-collector device (prefera[redacted] transistor) for the Inhibit input. <u>Do Not</u> u[redacted] resistor, or drive the input directly from [redacted] TTL or other logic gate. To disable [redacted] the control pin should be pulled l[redacted]
3. When the Inhibi[redacted] is active, i.e. pulled low, the [redacted] ltage is limited to +30Vdc.
4. [redacted] ibit input with an external DC [redacted] ad to erratic operation of the ISR and [redacted] he regulator.
5. [redacted] ance greater than 500pF at the Inhibit control [redacted] ssive capacitance at this pin will cause the ISR to [redacted] e a pulse on the output voltage bus at turn-on.
6. [redacted] ep the On/Off transition to less than 10µs. This prevents erratic operation of the ISR, which can cause a momentary high output voltage.

Figure 1



Tur[redacted] enabl[redacted] d automatically [redacted] input. The *Inhibit* control [redacted] pull-u[redacted] resistor. The ISR [redacted] utput [redacted] ltage within 1-msec of [redacted] Inhi[redacted] ontrol pin, or the application [redacted] ual [redacted] time will vary with the input [redacted] e total amount of capacitance connected t[redacted] sing the circuit of Figure 1, Figure 2 sho[redacted] se in output voltage for the PT6101 [redacted] n-off of Q1 at time t =0. The waveform was [redacted] a 9Vdc input voltage, and 5-Ohm resistive load.

F[redacted] 2



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