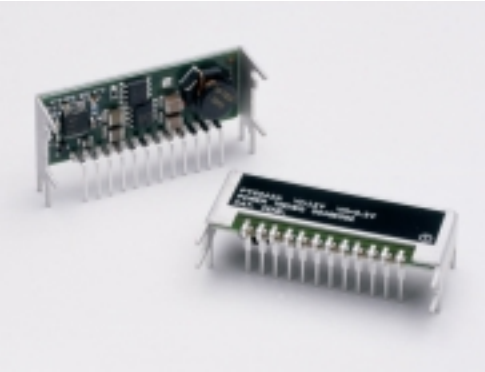
PT6340 Series

6-A 12-V Input Adjustable Integrated Switching Regulator

EXCALIBUR

SLTS138A

Revised (2/15/2002)



Features

- 6A Output Current
- Input Voltage Range: 10.8 V to 13.2 V
- 90% Efficiency
- Adjustable Output Voltage
- Standby Function
- Short Circuit Protection
- Small Footprint (0.61 in^2)
- Solderable Copper Case
- 8.8 10^6 Hours MTBF

Description

The PT6340 Excalibur™ power modules are a series of high performance Integrated Switching Regulators (ISRs), housed in a thermally efficient solderable copper case. These modules operate from a 12V input voltage bus to produce a high-output low-voltage power source; ideal for powering the industry's latest DSP and microprocessors. The series includes standard output bus voltages ranging from 5VDC to 1.2VDC.

The innovative copper case construction provides superior thermal performance in a small footprint. Both through-hole and surface mount pin configurations are available. The PT6340 series operating features include external output voltage adjustment, an On/Off inhibit, and short-circuit protection. A 100µF input, and 330µF output capacitor are required for proper operation.

Ordering Information

PT6341❒ = 5.0 Volts
PT6342❒ = 3.3 Volts
PT6343❒ = 2.5 Volts
PT6344❒ = 1.8 Volts
PT6345❒ = 1.5 Volts
PT6346❒ = 1.2 Volts

PT Series Suffix (PT1234x)

Case/Pin Configuration	Order Suffix	Package Code *
Vertical	**N**	(EPH)
Horizontal	**A**	(EPJ)
SMD	**C**	(EPK)

** Previously known as package styles 1540/50.*

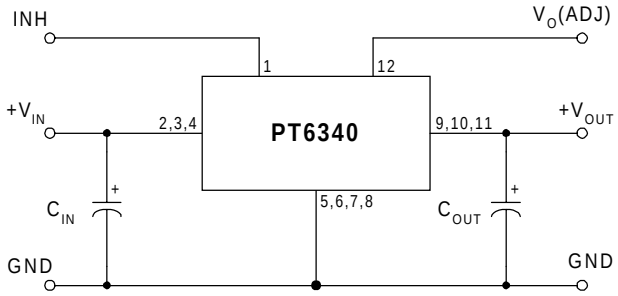
(Reference the applicable package code drawing for the dimensions and PC board layout)

Pin-Out Information

Pin	Function
1	Inhibit *
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 *

* *For further information, see application notes.*

Standard Application



C_{in} = Required 100µF electrolytic
C_{out} = Required 330µF electrolytic

Specifications (Unless otherwise stated, T_a =25°C, V_{in} =12V, C_{in} =100µF, C_{out} =330µF, and I_o =$I_o$max)

Characteristic	Symbol	Conditions	PT6340 SERIES Min	Typ	Max	Units
Output Current	I_o	T_a =+60°C, 200LFM T_a =+25°C, natural convection	0.1 (1) 0.1 (1)	— —	6 6	A
Input Voltage Range	V_{in}	Over I_o Range	10.8	—	13.2	VDC
Set Point Voltage Tolerance	V_o tol		—	±1	±2	%V_o
Temperature Variation	Reg_{temp}	–40° ≤T_a≤ +85°C, I_o =$I_o$min	—	±0.5	—	%V_o
Line Regulation	Reg_{line}	Over V_{in} range	—	±5	±10	mV
Load Regulation	Reg_{load}	Over I_o range	—	±5	±15	mV
Total Output Voltage Variation	ΔV_otot	Includes set-point, line, load, –40° ≤T_a≤ +85°C	—	±2	±3	%V_o
Efficiency	η	I_o =4A, V_o =5.0V	—	93	—	%
		V_o =3.3V	—	92	—	
		V_o =2.5V	—	91	—	
		V_o =1.8V	—	89	—	
		V_o =1.5V	—	87	—	
		V_o =1.2V	—	85	—	
V_o Ripple (pk-pk)	V_r	20MHz bandwidth	—	20	—	mV_{pp}
Transient Response	t_{tr}	1A/µs load step, 50% to 100% $I_o$max	—	50	—	µs
	ΔV_{tr}	V_o over/undershoot	—	±60	—	mV
Short Circuit Threshold	I_{sc} threshold		—	8.5	—	A
Switching Frequency	f_s	Over V_{in} and I_o range	300	350	400	kHz
Inhibit (Pin 1)		Referenced to GND (pin 5)				
High-Level Input Voltage	V_{IH}		V_{in}–0.5	—	Open (2)	V
Low-Level Input Voltage	V_{IL}		–0.2	—	+0.5	
Low-Level Input Current	I_{IL}		—	–0.5	–	mA
Standby Input Current	I_{in} standby	pins 1 & 5 connected	—	+0.5	—	mA
External Output Capacitance	C_{out}	See application schematic	330	—	1,000	µF
External Input Capacitance	C_{in}	See application schematic	100	—	—	µF
Operating Temperature Range	T_a	Over V_{in} range	–40 (3)	—	+85 (4)	°C
Storage Temperature	T_s	—	–40	—	+125	°C
Reliability	MTBF	Per Bellcore TR-332 50% stress, T_a =40°C, ground benign	8.8	—	—	10^6 Hrs
Mechanical Shock	—	Per Mil-Std-883D, method 2002.3, 1ms, half-sine, mounted to a fixture	—	500	—	G's
Mechanical Vibration	—	Mil-Std-883D, Method 2007.2, 20-2000Hz, soldered in PCB	—	20 (5)	—	G's
Weight	—		—	23	—	grams
Flammability	—	Materials meet UL 94V-0				

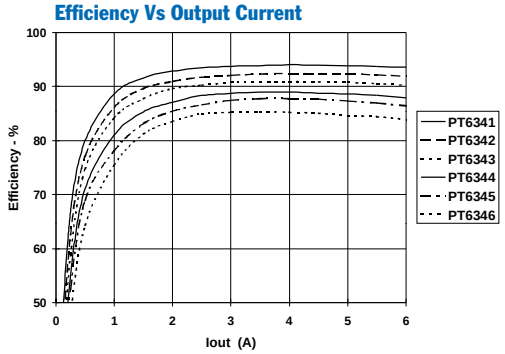
Notes: *(1) The ISR will operate at no load with reduced specifications.*
(2) The Inhibit control (pin 1) has an internal pull-up and if it is left open circuit the module will operate when input power is applied. The open-circuit voltage is the input voltage V_{in}. Use a discrete MOSFET to control the Inhibit pin, and ensure a transitioin time of less than ≤10µs. Consult the related application note for other interface considerations.
(3) For operation below 0°C, Cin and Cout must have stable characteristics. Use either low ESR tantalum or Oscon® capacitors.
(4) See Safe Operating Area curves or contact the factory for the appropriate derating.
(5) The case pins on through-hole package types (suffixes N & A) must be soldered. For more information consult the applicable package outline drawing.

Input/Output Capacitors: *The PT6340 regulator series requires a 100µF electrolytic (or tantalum) capacitor at the input and 330µF at the output for proper operation in all applications. In addition, the input capacitance, C_{in}, must be rated for a minimum of 740mArms of ripple current, and the ESR of the output capacitor, C_{out}, must less than 50mΩ @100kHz. For transient or dynamic load applications additional output capacitance may be necessary. For more information consult the related application note on capacitor recommendations.*

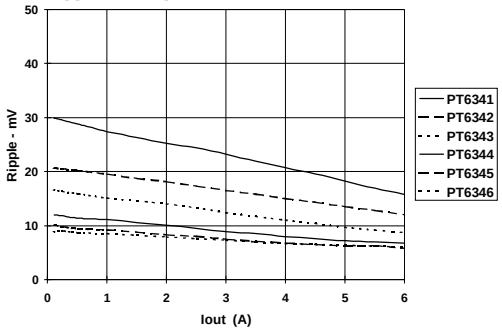
Typical Characteristics

PT6340 Series Performance; @V_{IN} =12.0V (See Note A)

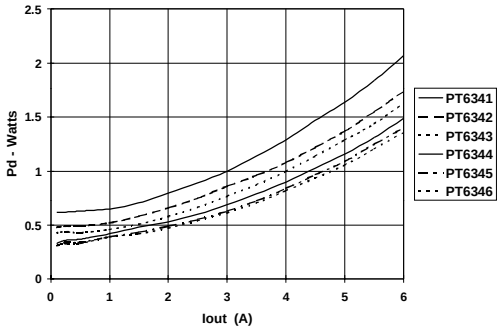
Efficiency Vs Output Current



Ripple Vs Output Current

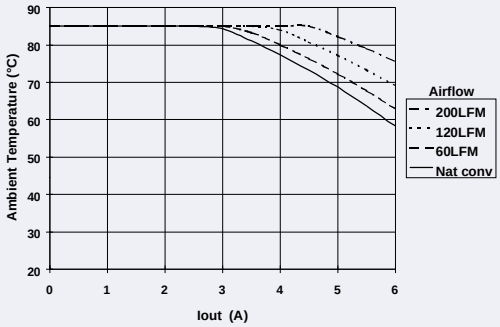


Power Dissipation Vs Output Current

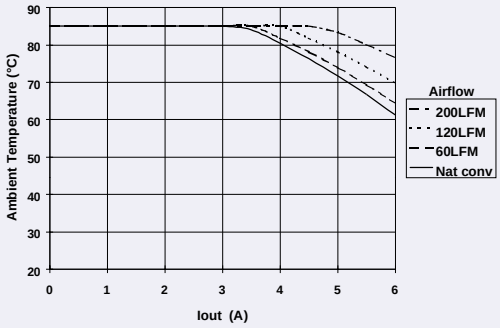


Safe Operating Area (See Note B)

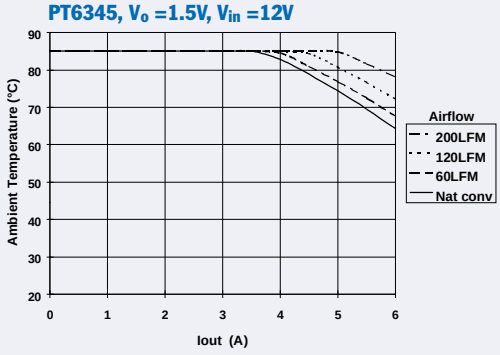
PT6341, V_o =5.0V, V_{in} =12V



PT6342, V_o =3.3V, V_{in} =12V



PT6345, V_o =1.5V, V_{in} =12V



Note A: *Characteristic data has been developed from actual products tested at 25°C. This data is considered typical data for the Converter.*
Note B: *SOA curves represent the conditions at which internal components are at or below the manufacturer's maximum operating temperatures*

Using the Inhibit Function on the PT6340 12V Bus Excalibur™ Series Converters

The PT6340 series are high efficiency regulators that are designed to operate off a 12V input bus. These devices incorporate an inhibit function, which may be used in applications that require a power-up/shutdown feature.

The inhibit function is provided by the *Inhibit** control, pin 1. If pin 1 is left open-circuit the regulator operates normally, and provides a regulated output whenever a valid supply voltage is applied to V_{in} (pins 2– 4) with respect to GND (pins 5–8). If a low voltage [2] is then applied to pin 1 the regulator output will be disabled and the input current drawn by the ISR will typically drop to 0.5mA [4]. The standby control may also be used to hold-off the regulator output during the period that input power is applied.

The *Inhibit** input can be controlled with an open-collector (or open-drain) discrete transistor (See Figure 1). The input is internally pulled-up to the input voltage, V_{in} [1]. Table 1 gives the control voltage requirements.

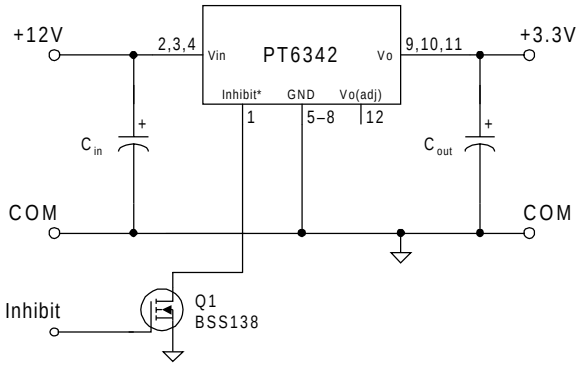
Table 1 Inhibit Control Requirements [3]

Parameter	Min	Typ	Max
V_{IL}	-0.1V		0.6V
V_{IH}	2.0V		V_{in}
I_{IL}		0.5mA	

Notes:

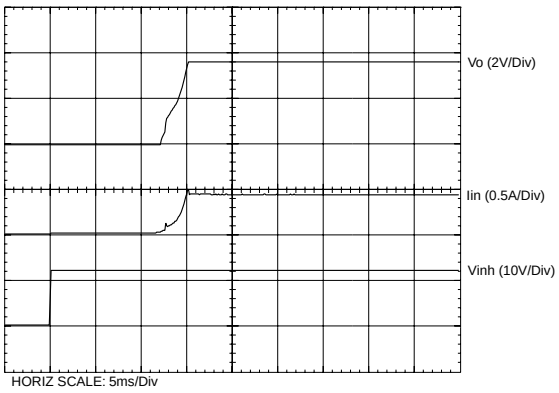
1. The inhibit control input requires no external pull-up resistor. The open-circuit voltage of the *Inhibit** input is typically the input voltage, V_{in}.
2. The inhibit control input is *Not* compatible with TTL devices. An open-collector device, preferably a discrete bipolar transistor (or MOSFET) is recommended. To ensure the regulator output is disabled, the control pin must be pulled to less than 0.6Vdc with a low-level 0.5mA sink to ground.
3. An external source voltage can be used to control the *Inhibit** pin. To guarantee the inhibit and enable status of the regulator, the source must be capable of meeting the voltage requirements in Table 1 .
4. When the regulator output is disabled the current drawn from the input source is typically reduced to 0.5mA.

Figure 1



Turn-On Time: In the circuit of Figure 1, turning Q_1 on applies a low voltage to the *Inhibit** control (pin 1) and disables the regulator ouput. Correspondingly, turning Q_1 off removes the low-voltage signal and enables the output. Once enabled, the output will typically experience a 10–15ms delay followed by a predictable ramp-up of voltage. The regulator should provide a fully regulated output voltage within 30ms. The waveform of Figure 2 shows the output voltage response of a PT6342 (3.3V) following the turn-off of Q_1. The turn off of Q_1 corresponds to the rise in V_{inh}. The waveforms were measured with a 12Vdc input voltage, and 2 ½ Adc load.

Figure 2



Capacitor Recommendations for the PT6340 6A Excalibur™ Regulator Series

Input Capacitors:
Output Current ≤4A Continuous (Table 1)

The recommended input capacitance is determined by 740 milli-amperes (rms) minimum ripple current rating, less than 100mΩ ESR (equivalent series resistance), and 100µF minimum capacitance. The ripple current rating, ESR, and operating temperature are the major considerations when selecting the input capacitor.

It is recommended that tantalum capacitors have a minimum voltage rating of twice (2×) the maximum dc voltage, plus the ac ripple. This is necessary to insure reliability with 12V input voltage bus applications. None of the 100µF tantalum capacitors were found to meet this requirement.

Input Capacitors:
Output Current >4A Continuous (Table 2)

The recommended input capacitance is determined by 1.0 amperes (rms) minimum ripple current rating and 100µF minimum capacitance. The ripple current rating, combined with less than 100mΩ ESR (equivalent series resistance) value are the major considerations, along with temperature, when selecting the input capacitor.

It is recommended that tantalum capacitors have a minimum voltage rating of twice (2×) the maximum dc voltage, plus the ac ripple. This is necessary to insure reliability for 12V input voltage bus applications. None of the 100µF tantalum capacitors were found to meet this requirement.

Output Capacitors:
Output Current 0–6A (Table 1 & Table 2)

The ESR of the required capacitor must be less than, or equal to 50mΩ. Electrolytic capacitors have poor ripple performance at frequencies greater than 400kHz but excellent low frequency transient response. Above the ripple frequency, ceramic decoupling capacitors are necessary to improve the transient response and reduce any high frequency noise components apparent during higher current excursions. Preferred low ESR type capacitor's part numbers are identified in the capacitor tables.

Tantalum Capacitors

Tantalums are acceptable on the output bus but only the AVX TPS series, Sprague 593D/594/595 series or Kemet T495/T510 series. These capacitors are recommended over many other types due to their higher rated surge, power dissipation, and ripple current capability. As a caution, the TAJ series by AVX is not recommended. This series exhibits considerably higher ESR and lower ripple current capability. The TAJ series is also less reliable than the TPS series when determining power dissipation capability. Tantalum or Oscon capacitor types are recommended for applications where ambient temperatures fall below 0°C.

Capacitor Tables

Table 1 and Table 2 identify the vendors with acceptable ESR and maximum allowable ripple current (rms) ratings. The output capacitors are identified in both tables under the "Output Bus" column with the required quantity.

The input capacitors are listed in both tables. Table 1 has the recommended input capacitors when operating the ISR at a load current of 4Adc or less, and Table 2 identifies input capacitors for ISR load currents greater than 4Adc.

This is not an extensive capacitor list. Capacitors from other vendors are available with comparable specifications. Those listed are for guidance. The RMS ripple current rating and ESR (Equivalent Series Resistance at 100kHz) are critical parameters necessary to insure both optimum regulator performance and long capacitor life.

Table 1: Input/Output Capacitors (Output Current ≤4 Amperes Continuous)

Capacitor Vendor/ Component Series	Capacitor Characteristics					Quantity		
	Working Voltage	Value(µF)	(ESR) Equivalent Series Resistance	Max Ripple Current @85°C (Irms)	Physical Size (mm)	Input Bus	Output Bus	Vendor Number
Panasonic FC (Radial)	35V 35V 50V	220µF 180µF 680µF	0.09Ω ÷2 0.09Ω ÷2 0.048Ω	755mA 755mA 1835mA	10 ×12.5 10 ×12.5 16 ×20	1 1 1	2 2 1	EEUFC1V221 EEUFC1V181 EEUFC1H681
FC (Surface Mount)	63V 35V 35V	220µF 330µF 470µF	0.09Ω ÷2 0.12Ω ÷3 0.043Ω	1410mA 1205mA 1690mA	16 ×16.5 12.5 ×16 16 ×16.5	1 1 1	2 3 1	EEVFC1J221N EEVFC1V331LQ EEVFC1V471N
United Chemi-Con, LXV/LXZ	50V 35V	120µF 220µF	0.12Ω ÷3 0.09Ω ÷2	755mA 760mA	10 ×16 10 ×12.5	1 1	3 2	LXV50VB121M10X16LL LXZ35VB221M10X12LL
FS	10V 20V	330µF 150µF	0.025Ω 0.03Ω ÷2	3500mA 3200mA	10 ×10.5 10 ×10.5	N/R 1	1 2	10FS330M 20FS150M
Nichicon, PL	35V 35V	560µF 330µF	0.048Ω 0.065Ω ÷2	1360mA 1020mA	16 ×15 12.5 ×15	1 1	1 2	UPL1V561MHH6 UPL1V331MHH6
PM	50V	470µF	0.046Ω	1470mA	18 ×15	1	1	UPM1H4711MHH6
Oscon, SS (Radial)	10V	330µF	0.025Ω	>3500mA	10.0 ×10.5	N/R	1	10SS330M
SV (Surface Mount)	10V 20V	330µF 150µF	0.025Ω 0.024Ω ÷2	>3800mA 3600mA	10.3 ×10.3 10.3 ×10.3	N/R 1	1 2	10SV300M 20SV150M
AVX Tantalum TPS	10V 10V 25V	330µF 330µF 68µF	0.1Ω ÷2 0.1Ω ÷2 0.095Ω	>2500mA >3000mA >2000mA	7.3L ×4.3W ×4.1H	N/R N/R 2	2 2 N/R	TPSV337M010R0100 TPSV337M010R0060 TPSV686M025R0095
Kemet, T510 T495	10V 10V	330µF 220µF	0.033Ω 0.07Ω ÷2	1400mA >2000mA	7.3L ×5.7W ×4.0H	N/R N/R	1 2	T510X337M010AS T495X227M010AS
Sprague, 594D	10V 25V	330µF 68µF	0.0450Ω 0.095Ω	2350mA 1600mA	7.3L × 6.0W ×4.1H	N/R 2	1 N/R	594D337X0010R2T 594D686X0025R2T

N/R –Not recommended. The voltage rating does not meet the minimin operating limits.

Table 2: Input/Output Capacitors (Output Current >4 Amperes Continuous)

Capacitor Vendor/ Component Series	Capacitor Characteristics					Quantity		
	Working Voltage	Value(µF)	(ESR) Equivalent Series Resistance	Max Ripple Current @85°C (Irms)	Physical Size (mm)	Input Bus	Output Bus	Vendor Number
Panasonic, FC (Radial)	35V 35V 50V	680µF 560µF 680µF	0.043Ω 0.038Ω 0.048Ω	1655mA 1655mA 1835mA	12.5 ×20 12.5 ×20 16 ×20	1 1 1	1 1 1	EEUFC1V681 EEUFC1V561S EEUFC1H681
FC (Surface Mount)	63V 35V 35V	220µF 330µF 470µF	0.09÷2Ω 0.12÷3Ω 0.043Ω	1410mA 1205mA 1690mA	16 ×16.5 12.5 ×16 16 ×16.5	1 1 1	2 3 1	EEVFC1J221N EEVFC1V331LQ EEVFC1V471N
Un ited Chemi-con LXV/LXZ/ FX/FS	35V 25V 10V 20V	330µF 820µF 390µF 150µF	0.068Ω 0.046Ω 0.030Ω 0.024Ω	1050mA 1340mA 3080mA 3200mA	10 ×16 12 ×20 8 ×10.5 8 ×10.5	1 1 N/R 1	2 1 1 2	LXZ35VB331M110X16LL LXV25VB820M12X20LL 10FX390M 20FX150M
Nichicon, PL	35V 35V	560µF 330µF	0.048Ω 0.06÷2Ω	1360mA 1020mA	16 ×15 12.5 ×15	1 1	1 2	UPL1V561MHH6 UPL1V331MHH6
PM	35V	560µF	0.0048Ω	1360mA	16 ×15	1	1	UPM1V561MHH6
Oscon, SS (Radial)	10V	330µF	0.025Ω	>3500mA	10.0 ×10.5	N/R	1	10SS330M
SV (Surface Mount)	10V 20V	330µF 150µF	0.025Ω 0.02÷2Ω	>3800mA 3600mA	10.3 ×10.3 10.3 ×10.3	N/R 1	1 2	10SV330M 20SV150M
AVX Tantalum, TPS	10V 10V 25V	330µF 330µF 68µF	0.1÷2Ω 0.1÷2Ω 0.095Ω	>2500mA >3000mA >2000mA	7.3L ×4.3W ×4.1H	N/R N/R 2	2 2 N/R	TPSV337M010R0100 TPSV337M010R0060 TPSV686M025R0095
Kemet, T510 T495	10V 10V	330µF 220µF	0.033Ω 0.07Ω÷2	1400mA >2000mA	7.3L x5.7W ×4.0H	N/R N/R	1 2	T510X337M010AS T495X227M010AS
Sprague, 594D	10V 25V	330µF 68µF	0.045Ω 0.095Ω	2350mA 1600mA	7.3L ×6.0W ×4.1H	N/R 2	1 N/R	594D337X0010R2T 594D686X0025R2T

N/R –Not recommended. The voltage rating does not meet the minimin operating limits.

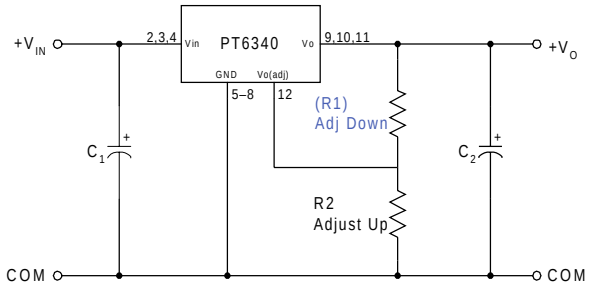
Adjusting the Output Voltage of the PT6340 Excalibur™ 6 A, 12 V Bus Step-Down ISRs

The output voltage of the PT6340 Series ISRs may be adjusted higher or lower than the factory trimmed pre-set voltage with the addition of a single external resistor. Table 1 accordingly gives the allowable adjustment range for each model for either series as V_a (min) and V_a (max).

Adjust Up: An increase in the output voltage is obtained by adding a resistor R_2, between pin 12 (V_o adj) and pins 5-8 (GND).

Adjust Down: Add a resistor (R_1), between pin 12 (V_o adj) and pins 9-11 (V_o).

Figure 1



The values of (R_1) [adjust down], and R_2 [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 (R_1) or R_2 as appropriate.

$$(R_1) = \frac{R_o\,(V_a - V_r)}{V_o - V_a} - R_s \quad k\Omega$$

$$R_2 = \frac{V_r \cdot R_o}{V_a - V_o} - R_s \quad k\Omega$$

Where: V_o = Original output voltage
V_a = Adjusted output voltage
V_r = Reference voltage (Table 1)
R_o = Resistance constant (Table 1)
R_s = Internal series resistance (Table 1)

Notes:

1. Use only a single 1% resistor in either the (R_1) or R_2 location. Place the resistor as close to the ISR as possible.
2. Never connect capacitors from V_o adj to either GND or V_{out}. Any capacitance added to the V_o adjust pin will affect the stability of the ISR.

Table 1

ISR ADJUSTMENT RANGE AND FORMULA PARAMETERS

Series Pt #	PT6341	PT6342	PT6343	PT6244	PT6345	PT6346
V_o (nom)	5.0	3.3	2.5	1.8	1.5	1.2
V_a (min)	4.0	2.8	2.2	1.7	1.45	1.1
V_a (max)	5.5	3.8	3.0	2.3	2.0	1.45
V_r (V)	1.27	1.27	1.27	1.27	1.27	0.8
R_o (kΩ)	10.0	10.0	10.0	10.0	10.0	10.0
R_s (kΩ)	24.9	24.9	24.9	24.9	24.9	24.9

Table 2

ISR ADJUSTMENT RESISTOR VALUES

Series Pt #	PT6343	PT6344	PT6345	PT6346	Series Pt #	PT6341	PT6342
V_o (nom)	2.5	1.8	1.5	1.2V	V_o (nom)	5.0	3.3V
V_a (req'd)					V_a (req'd)		
1.1				(5.1)kΩ	2.8		(5.7)kΩ
1.15				(45.1)kΩ	2.85		(10.2)kΩ
1.2					2.9		(15.8)kΩ
1.25				135.0kΩ	2.95		(22.9)kΩ
1.3				55.1kΩ	3.0		(32.8)kΩ
1.35				28.4kΩ	3.05		(46.3)kΩ
1.4				15.1kΩ	3.1		(66.6)kΩ
1.45			(11.1)kΩ	7.1kΩ	3.15		(100.0)kΩ
1.5					3.2		(168.0)kΩ
1.55			229.0kΩ		3.25		(371.0)kΩ
1.6			102.0kΩ		3.3		
1.65			59.8kΩ		3.35		229.0kΩ
1.7		(18.1)kΩ	38.6kΩ		3.4		102.0kΩ
1.75		(71.1)kΩ	25.9kΩ		3.45		59.8kΩ
1.8			17.4kΩ		3.5		38.6kΩ
1.85		229.0kΩ	11.4kΩ		3.6		17.4κΩ
1.9		102.0kΩ	6.9kΩ		3.7		6.9kΩ
1.95		59.8kΩ	3.3kΩ		3.8		0.5kΩ
2.0		38.6kΩ	0.5kΩ		4.0	(2.4)kΩ	
2.05		25.9kΩ			4.1	(6.5)kΩ	
2.1		17.4kΩ			4.2	(11.7)kΩ	
2.15	(0.0)kΩ	11.4kΩ			4.3	(18.4)kΩ	
2.2	(6.1)kΩ	6.9kΩ			4.4	(27.3)kΩ	
2.25	(14.3)kΩ	3.3kΩ			4.5	(39.7)kΩ	
2.3	(26.6)kΩ	0.5kΩ			4.6	(58.3)kΩ	
2.35	(47.1)kΩ				4.7	(89.4)kΩ	
2.4	(88.1)kΩ				4.8	(152.0)kΩ	
2.45	(206.0)kΩ				4.9	(338.0)kΩ	
2.5					5.0		
2.55	229.0kΩ				5.1	102kΩ	
2.6	102.0kΩ				5.2	38.6kΩ	
2.65	59.8kΩ				5.3	17.4kΩ	
2.7	38.6kΩ				5.4	6.9kΩ	
2.75	25.9kΩ				5.5	0.5kΩ	
2.8	17.4kΩ						
2.85	11.4kΩ						
2.9	6.9kΩ						
2.95	3.4kΩ						
3.0	0.5kΩ						

R1 = (Blue) R2 = Black

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