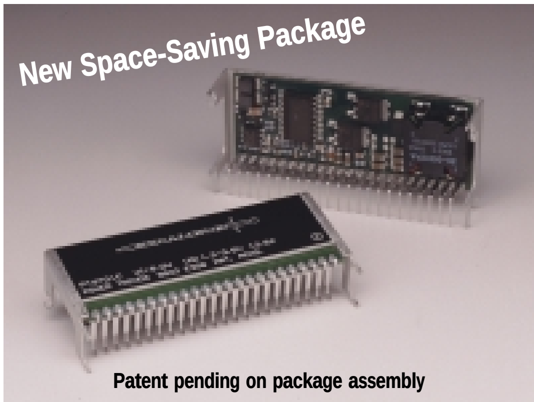
13 Amp Programmable Integrated Switching Regulator



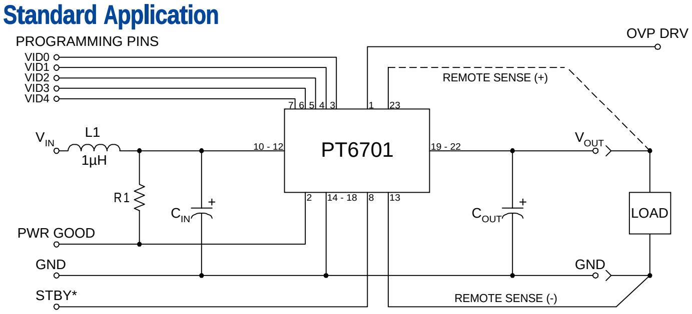
- +5V input
- 5-bit Programmable: 1.3V to 3.5V@13A
- High Efficiency
- Differential Remote Sense
- Over-Voltage Drive
- Power Good Signal
- Short Circuit Protection
- 23-Pin Space Saving Package
- Solderable Copper Case

The PT6701 is a 13 Amp fully integrated switching regulator housed in a unique space-saving package. The PT6701 operates from +5V input to provide a high-performance low-voltage power source for the industy's latest µPs, DSPs, and bus drivers.

The PT6701 output is programmable from 1.3V to 3.5V with a 5-bit input, compatible with Intel's Pentium® II Processor.

The PT6701 has short circuit protection, a "Power Good" output, and an over-voltage protection (OVP) drive output.

Standard Application



C_{in} = Required 1000µF electrolytic
C_{out} = Required 330µF electrolytic
L1 = Optional 1µH input choke
R1 = Required 10kΩ pull-up when using Pwr Good signal. Pwr good output is high when the output voltage is within specification.

PT6700 Product Family

	Input Voltage	Vout Adjust	OVP/ Pwr Good	Requires +12V Bias
PT6701	5V	VID	✓	
PT6702	3.3V	VID	✓	
PT6705	5V	Resistor		✓
PT6715	5V	Resistor		
PT6721	12V	VID	✓	
PT6725	12V	Resistor		

Specifications

Characteristics (T_a = 25°C unless noted)	Symbols	Conditions	PT6700 SERIES Min	Typ	Max	Units
Output Current	I_o	T_a = +60°C, 200 LFM, pkg N T_a = +25°C, natural convection	0.1 (1) 0.1 (1)	— —	13 13	A
Input Voltage Range	V_{in}	$0.1A \le I_o \le 13A$	4.5	—	5.5	V
Output Voltage Tolerance	ΔV_o	V_{in} = +5V, I_o = 13A $-40°C \le T_a \le +85°C$	Vo-0.03	—	Vo+0.03	V
Line Regulation	Reg_{line}	$4.5V \le V_{in} \le 5.5V$, I_o = 13A	—	±10	—	mV
Load Regulation	Reg_{load}	V_{in} = +5V, $0.1 \le I_o \le 13A$	—	±20	—	mV
V_o Ripple/Noise	V_n	V_{in} = +5V, I_o = 13A	—	50	—	mV
Transient Response with C_{out} = 330µF	t_{tr} V_{os}	I_o step between 6A and 12A V_o over/undershoot	— —	70 100	— —	µSec mV
Efficiency	η	V_{in} = +5V, I_o = 9A — V_o = 3.3V V_o = 2.9V V_o = 2.5V V_o = 1.8V V_o = 1.5V	— — — — —	91 90 88 85 83	— — — — —	%
Switching Frequency	f_o	$4.5V \le V_{in} \le 5.5V$ $0.1A \le I_o \le 13A$	300	350	400	kHz
Absolute Maximum Operating Temperature Range	T_a	Over V_{in} Range	-40 (2)	—	+85 (3)	°C
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	—	15	—	G's
Weight	—	—	—	26	—	grams

Notes: (1) *The ISR will operate down to no load with reduced specifications.*
(2) *For operation below 0°C, Cin and Cout must have stable characteristics. Use either low ESR tantalum or Oscon® capacitors.*
(3) *See Safe Operating Area curves or consult factory for appropriate derating.*
(4) *If the remote sense ground is not used, pin 13 must be connected to pin 14 for optimal output voltage accuracy.*

Output Capacitors: *The PT6700 series requires a minimum ouput capacitance of 330µF. The maximum allowable output capacitance is 15,000µF.*

Input Filter: *An input filter is optional for most applications. The input inductor must be sized to handle 10.0ADC with a typical value of 1µH. The input capacitance must be rated for a minimum of 2.0Arms of ripple current. For transient or dynamic load applications, additional capacitance may be required.*

13 Amp Programmable Integrated Switching Regulator

Pin-Out Information

Pin	Function	Pin	Function
1	OVP Drive	13	Remote Sense Gnd (4)
2	Pwr Good	14	GND
3	VID0	15	GND
4	VID1	16	GND
5	VID2	17	GND
6	VID3	18	GND
7	VID4	19	V_{out}
8	STBY*	20	V_{out}
9	Do not connect	21	V_{out}
10	V_{in}	22	V_{out}
11	V_{in}	23	Remote Sense V_{out}
12	V_{in}		

STBY* pin; Open = output enabled
Gnd = output disabled.

Programming Information

VID3	VID2	VID1	VID0	VID4=1 Vout	VID4=0 Vout
1	1	1	1	2.0V	1.30V
1	1	1	0	2.1V	1.35V
1	1	0	1	2.2V	1.40V
1	1	0	0	2.3V	1.45V
1	0	1	1	2.4V	1.50V
1	0	1	0	2.5V	1.55V
1	0	0	1	2.6V	1.60V
1	0	0	0	2.7V	1.65V
0	1	1	1	2.8V	1.70V
0	1	1	0	2.9V	1.75V
0	1	0	1	3.0V	1.80V
0	1	0	0	3.1V	1.85V
0	0	1	1	3.2V	1.90V
0	0	1	0	3.3V	1.95V
0	0	0	1	3.4V	2.00V
0	0	0	0	3.5V	2.05V

Logic 0 = Pin 13 potential (remote sense gnd)
Logic 1 = Open circuit (no pull-up resistors)
VID3 and VID4 may not be changed while the unit is operating.

Ordering Information

PT6701❑ = 1.3 to 3.5 Volts

(For dimensions and PC board layout, see Package Styles 1300 and 1310.)

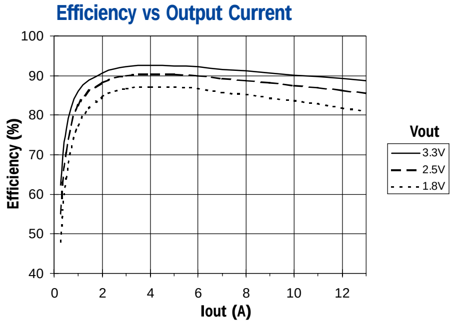
PT Series Suffix (PT1234X)

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

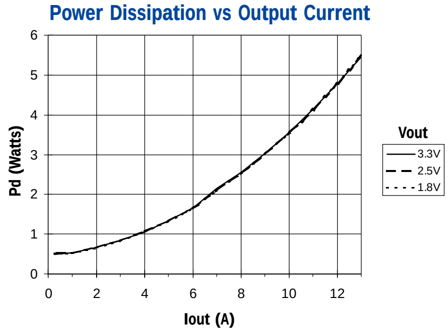
TYPICAL CHARACTERISTICS

PT6701, Vin = 5.0V (See Note A)

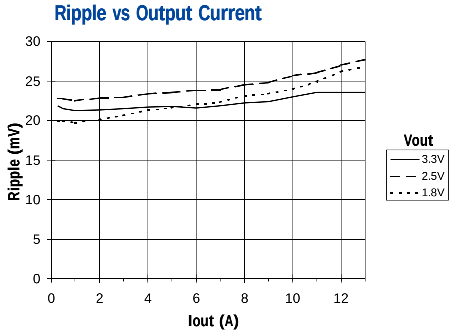
Efficiency vs Output Current



Power Dissipation vs Output Current

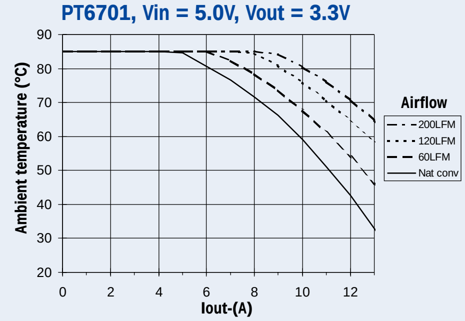


Ripple vs Output Current



Safe Operating Area Curves (See Note B)

PT6701, Vin = 5.0V, Vout = 3.3V



Note A: *Characteristic data has been developed from actual products tested at 25°C. This data is considered typical for the ISR*

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

Operating Features of the Programmable PT6700 "Excalibur™" Series ISRs

Power Good

Programmable versions of the PT6700 Series regulators incorporate a *PWR Good* output (pin 2). This output is open-drain and generates an acitve-high signal when the sensed output from the ISR is within a nominal ±10% of the programmed set point. When the regulated output is outside this range, pin 2 asserts a logic low (typically <0.1V). A 10KΩ pull-up resistor to a valid bus voltage is required. If the power good feature is not used, the pull-up resistor can be omitted. The maximum voltage that may be applied to the pull-up resistor is 15V.

Over-Voltage Protection (OVP)

The PT6700 programmable regulators also incorporate an OVP function. The *OVP DRV* (pin 1) normally has a logic low output (typically <0.1V). When the ISR's sensed output exceeds the programmed output setting by 15%, pin 1 produces a 60mA, +12V drive signal. This drive signal can trigger an SCR, which can be used to disable the input voltage, or alternatively interface to another external monitoring device. When the ISR output voltage returns to within 15% of its programmed setting, pin 1 reverts back to its low state. If the OVP function is not used, pin 1 may be left open circuit.

Stand-By Function

The PT6700 series ISRs incorporate a standby function. This feature may be used for power-up sequencing, or wherever there is a requirement for the output voltage to be controlled by external circuitry.

If the *STBY** input (pin 8) is left open-circuit the regulator operates normally, providing a regulated output when a valid supply voltage is applied to V_{in} (pins 10-12) with respect to GND (pins 14-18). Connecting pin 8 to ground [1] places the regulator in standby mode, and reduces the input current to typically 20mA (30mA max). Applying a ground signal to pin 8 prior to power-up, will disable the output during the period that input power is applied. To ensure that the regulator output is fully enabled, pin 8 must be allowed to rise to a minimum of 3.0V.

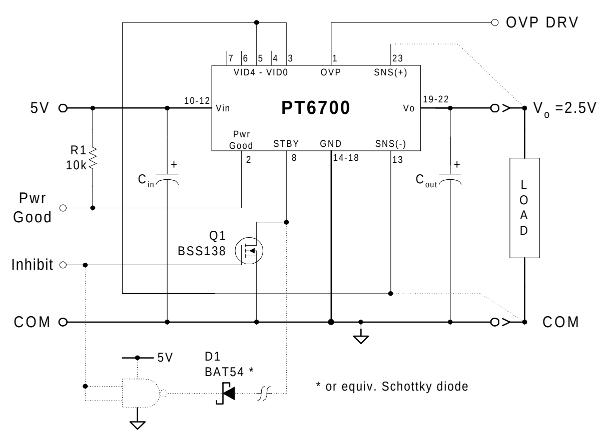
Notes:

1. The standby on the PT6700 series is ideally controlled with an open-collector (or open-drain) discrete transistor (See fig. 1). Table 1 gives the threshold requirements. Do Not use a pull-up resistor. The control input has an open-circuit voltage of about 4.0Vdc. To set the regulator output to zero, the control pin must be "pulled" to less than 1.0Vdc with a sink to ground.
2. The Standby input can also be interfaced to TTL or other bi-directional output device using a schottky diode. See Figure 1.
3. When placed in the standby mode, the regulator output may assert a low impedance to ground. If an external voltage is applied to the output, it will sink current and possibly over-stress the part.

Table 1 Inhibit Control Threshold [2,3]

Parameter	Min	Typ	Max
Enable (V_{IH})	3.0V		
Disable (V_{IL})	-0.1V	0.4V	1..0V
I_{stby}		0.01mA	

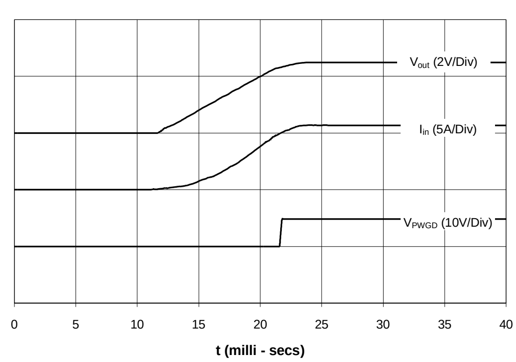
Figure 1



Turn-On Time

Turning Q_1 in Figure 1 off, removes the low-voltage signal at pin 8 and enables the output. Following a brief delay of 10-15ms, the output voltage of the PT6700 regulator rises to full regulation within 30ms. Figure 2 shows the typical output voltage waveform of a PT6701 following the prompt turn-off of Q_1 at time t =0 secs. The output voltage was set to 2.5V. The waveforms were measured with a 5V input source voltage, and 10A resistive load.

Figure 2



Pin-Coded Output Voltage Adjustment on Non-Isolated "Excalibur™" Series ISRs

The PT6701/6702/6721 Excalibur™ ISRs incorporate a pin-coded voltage control to adjust the ouput voltage. The control pins are identified VID0 - VID4 (pins 3–7) respectively. When these control pins are left open-circuit the ISR output will regulate at its factory trimmed output voltage. Each pin is internally connected to a precision resistor, which when grounded changes the output voltage by a set amount. By selectively grounding VID0-VID4, the output voltage these ISRs can be programmed in incremental steps over the specified output voltage range. The program code and output voltage range of these ISRs is compatible with the voltage ID specification defined by Intel Corporation. The code is used in conjuction with voltage regulator modules (VRMs) that are used to power Intel's Pentium® microprocessors. Refer to Figure 1 below for the connection schematic, and the respective device Data Sheet for the appropriate programming code information.

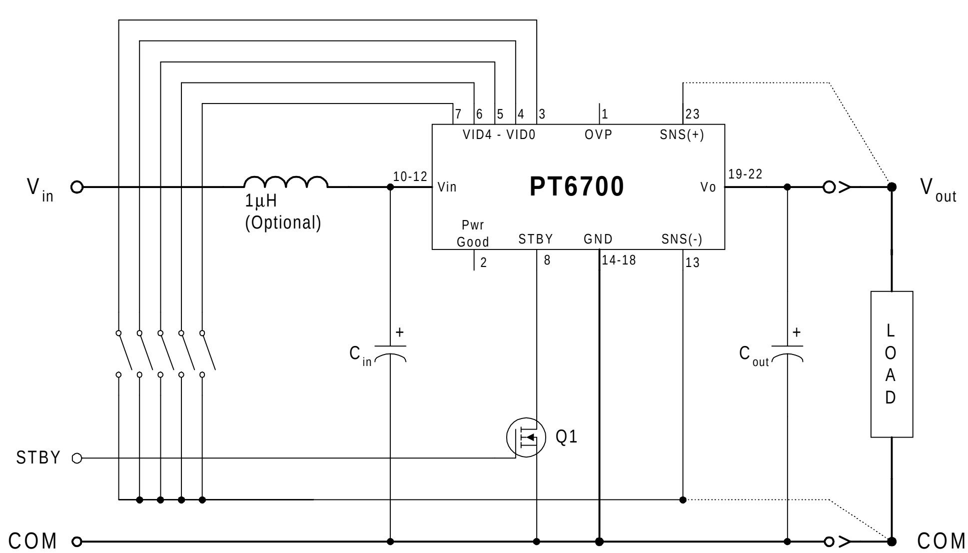
Notes:

1. The programming convention is as follows:-
   Logic 0: Connect to pin13 (Remote Sense Ground).
   Logic 1: Open circuit/open drain (See notes 2, & 4)
2. Do not connect pull-up resistors to the voltage programming pins.
3. To minimize output voltage error, always use pin 13 (Remote Sense Ground) as the logic "0" reference. While the regular ground (pins 14-18) can also be used for programming, doing so will degrade the load regulation of the product.
4. If active devices are used to ground the voltage control pins, low-level open drain MOSFET devices should be used over bipolar transistors. The inherent V_{ce}(sat) in bipolar devices introduces errors in the device's internal voltage control circuit. Discrete transistors such as the BSS138, 2N7002, IRLML2402, or the 74C906 hex open-drain buffer are examples of appropriate devices.

Active Voltage Programming:

Special precautions should be taken when making changes to the voltage control progam code while the unit is powered. It is highly recommended that the ISR be either powered down or held in standby. Changes made to the program code while V_{out} is enabled induces high current transients through the device. This is the result of the electrolytic output capacitors being either charged or discharged to the new output voltage set-point. The transient current can be minimized by making only incremental changes to the binary code, i.e. one LSB at a time. A minimum of 100µs settling time between each program state is also recommended. Making non-incremental changes to VID3 and VID4 with the output enabled is discouraged. If they are changed, the transients induced can overstress the device resulting in a permanent drop in efficiency. If the use of active devices prevents the program code being asserted prior to power-up, pull pin 8 (STBY) to the device GND during the period that the input voltage is applied to V_{in}. Releasing pin 8 will then allow the device output to initiate a soft-start power-up to the programmed voltage.

Figure 1



Capacitor Recommendations for the Non-Isolated 13A Excalibur™ Series of Regulators

Input Capacitors

The recommended input capacitance is determined by the 2.0 ampere minimum ripple current rating and 1000µF minimum capacitance. Capacitors listed below must be rated for a minimum of 2x the input voltage with +5V operation. Ripple current and ≤100mΩ Equivalent Series Resistance (ESR) values are the major considerations along with temperature when selecting the proper capacitor.

Output Capacitors

The minimum required output capacitance is 330µF with a maximum ESR less than or equal to 100mΩ. Failure to observe this requirement may lead to regulator instability or oscillation. 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 part numbers are identified in Table 1 below.

Tantalum Characteristics

Tantalum capacitors with a minimum 10V rating are recommended on the output bus, but only the AVX TPS Series, Sprague 594/595 Series, or Kemet T495/T510 Series. The AVX TPS Series, Sprague Series or Kemet Series capacitors are specified over other types due to their higher surge current, excellent power dissipation and ripple current ratings. As an example, the TAJ Series by AVX is not recommended. This series exhibits considerably higher ESR, reduced power dissipation and lower ripple current capability. The TAJ Series is a less reliable compared to the TPS series when determining power dissipation capability.

Capacitor Table

Table 1 identifies the characteristics of capacitors from a number of vendors with acceptable ESR and ripple current (rms) ratings. The suggested minimum quantities per regulator for both the input and output buses are identified.

This is not an extensive capacitor list. The table below is a suggested selection guide for input and output capacitors. Other capacitor vendors are available with comparable RMS ripple current rating and ESR (Equivalent Series Resistance at 100kHz). These critical parameters are necessary to insure both optimum regulator performance and long capacitor life.

Table 1 Capacitors Characteristic Data

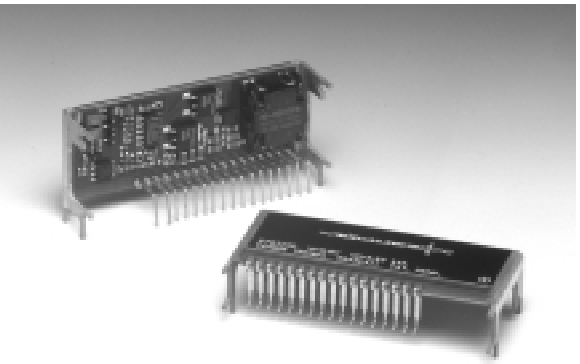
Capacitor Vendor Series	Capacitor Characteristics					Quantity		
	Working Voltage	Value(µF)	(ESR) Equivalent Series Resistance	85°C Maximum Ripple Current(Irms)	Physical Size(mm)	Input Bus	Output Bus	Vendor Number
Panasonic FC Surface Mtg FA Radial	25V 35V 25V 25V	1000 330 330 1200	0.038Ω 0.065Ω 0.090Ω 0.032Ω	2000mA 1205mA 765mA 2000mA	18x16.5 12.5x16.5 10x12.5 18x15	 1 1	1 1 1 1	EEVFC1E102N EEVFC1V331LQ EEUFA1E331 EEUFA1E122S
United Chemi -Con LFV Radial FX Surface Mtg	25V 35V 16V 10V	330 1200 2700 680	0.084Ω 0.028Ω 0.028Ω 0.015Ω/2=0.007Ω	825mA 2070mA 2070mA >7000mA	10x16 16x25 16x25 10X10.5	 1 1 2	1 1 1 1	LXV25VB331M10X16LL LXV35VB122M16X25LL LXV16VB272M16X25LL 10FX680M(Os-con)
Nichicon PL Series PM Series	25V 25V 25V	330 2200 330	0.095Ω 0.028Ω 0.095Ω	750mA 2050mA 750mA	10x15 18x20 10x15	 1 	1 1 1	UPL1E331MPH6 UPL1E222MHH6 UPM1E331MPH6
Oscon SS SV	10V 10V	330 330	0.025Ω/3=0.008Ω 0.020Ω/3=0.007Ω	>7000mA >7000mA	10x10.5 10.3x12.6	3 3	1 1	10SS330M 10SV330M(Surface Mtg)
AVX Tanatalum TPS- Series	10V 10V	330 330	0.100Ω/3=0.034Ω 0.060Ω/3=0.02Ω	>3500mA >3500mA	7.0Lx 5.97Wx 3.45H	3 3	1 1	TPSV337M010R0100 TPSV337M010R0060
Vishay/Sprague Tantalum 595D/594D	10V 10V	330 680	0.045Ω/3=0.015Ω 0.090Ω/4=0.023Ω	>4600mA >2500mA	7.2L x 6.0W x 3.5H	3 2	1 1	594D337X0010R2T Surface Mount 595D687X0010R2T
Kemet Tantalum T510/T495 Series	10V 10V	330 220	0.035Ω/3=0.012Ω 0.070Ω/5=0.035Ω	>5000mA >3000mA	4.3Wx7.3L x4.0H	3 5	1 2	T510X337M010AS T495X227M010AS Surface Mount
Sanyo Poscap TPB	10V	220	0.040Ω/5=0.008Ω	>3000mA	7.2L x 4.3W x 3.1H	5	2	10TPB220M Surface Mount

Power Trends Products from Texas Instruments

13 Amp 5V/3.3V Input Adjustable Integrated Switching Regulator

EXCALIBUR

SLTS100
(Revised 6/30/2000)



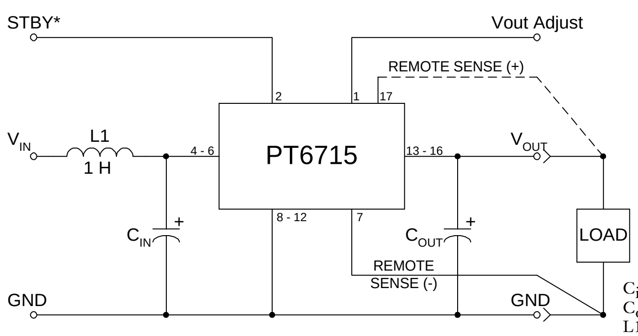
Patent pending on package assembly

- +3.3V/5V Input Voltage
- Adjustable Output Voltage
- 90% Efficiency
- Standby
- Differential Remote Sense
- 17-Pin Space–Saving Package
- Solderable Copper Case
- Short Circuit Protection

The PT6715 is a series of high-performance, 13A Integrated Switching Regulators (ISRs) housed in a unique, space-saving 17-pin package. The PT6715 will operate off either a 5V or 3.3V power bus to provide a low-voltage power source for the industry's latest high-speed, DSPs, µPs, and bus drivers.

Features include a Standby function, a differential remote sense, and short circuit protection.

Standard Application



C_{in} = Required 1000µF electrolytic
C_{out} = Required 330µF electrolytic
L1 = Optional 1µH input choke

Pin-Out Information

Pin	Function
1	V_{out} adjust
2	STBY*
3	Do not connect
4	V_{in}
5	V_{in}
6	V_{in}
7	Remote Sense Gnd (4)
8	GND
9	GND

Pin	Function
10	GND
11	GND
12	GND
13	V_{out}
14	V_{out}
15	V_{out}
16	V_{out}
17	Remote Sense V_{out}

For STBY* pin
open = output enabled
ground = output disabled.

Specifications

Characteristics (T_a = 25°C unless noted)	Symbols	Conditions	PT6715 SERIES Min	Typ	Max	Units
Output Current	I_o	T_a = +60°C, 200 LFM, pkg N, T_a = +25°C, natural convection	0.1 (1) 0.1 (1)	— —	13.0 13.0	A
Input Voltage Range	V_{in}	$0.1A \le I_o \le 13A$ PT6715/6 PT6717/8	4.5 3.1	— —	5.5 5.5	V
Output Voltage Tolerance	ΔV_o	V_{in} = +5V, I_o = 13A -40°C ≤ T_a ≤ +85°C	Vo-0.03	—	Vo+0.03	V
Short-Circuit Threshold	I_{sc}	V_{in} = +5V	—	18	30	A
Line Regulation	Reg_{line}	$4.5V \le V_{in} \le 5.5V$, I_o = 13A	—	±5	—	mV
Load Regulation	Reg_{load}	V_{in} = +5V, $0.1 \le I_o \le 13A$	—	±10	—	mV
V_o Ripple/Noise	V_n	V_{in} = +5V, I_o = 13A	—	35	—	mV
Transient Response with C_{out} = 330µF	t_{tr} V_{os}	I_o step between 6.5A and 13A V_o over/undershoot	— —	50 100	— —	µSec mV
Efficiency	η	V_{in} = +5V, I_o = 9A V_o = 3.3V V_o = 2.5V V_o = 1.8V V_o = 1.5V	— — — —	91 88 85 83	— — — —	%
Switching Frequency	f_o	$4.5V \le V_{in} \le 5.5V$ $0.1A \le I_o \le 13A$	300	350	400	kHz
Absolute Maximum Operating Temperature Range	T_a	Over V_{in} Range	-40 (2)	—	+85 (3)	°C
Storage Temperature	T_s	—	-40	—	+125	°C
Mechanical Shock		Per Mil-STD-883D, Method 2002.3 1ms half sine, mounted to a fixture	—	500	—	G's
Mechanical Vibration		Per Mil-STD-883D, Method2007.2, 20-2000Hz, Soldered in a PC board	—	15	—	G's
Weight	—	—	—	26	—	grams

Notes: *(1) ISR-will operate down to no load with reduced specifications.*
(2) For operationo below 0°C, Cin and Cout must have stable characteristics. Use either low ESR tantalum or Oscon® capacitors.
(3) See Safe Operating Area curves or contact the factory for the appropriate derating.
(4) If the remote sense ground is not used, pin 7 must be connected to pin 8 for optimum output voltage accuracy.

Output Capacitors: *The PT6715 requires a minimum ouput capacitance of 330µF for proper operation. The maximum allowable output capacitance is 15,000µF.*

Input Filter: *An input filter is optional for most applications. The input inductor must be sized to handle 10ADC with a typical value of 1µH. The input capacitance must be rated for a minimum of 2.0Arms of ripple current. For transient or dynamic load applications, additional capacitance may be required.*

PT6715 Series

13 Amp 5V/3.3V Input Adjustable Integrated Switching Regulator

Ordering Information

PT6715❑ = 3.3 Volts
PT6716❑ = 2.5 Volts
PT6717❑ = 1.8 Volts
PT6718❑ = 1.5 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 1340 and 1350.)

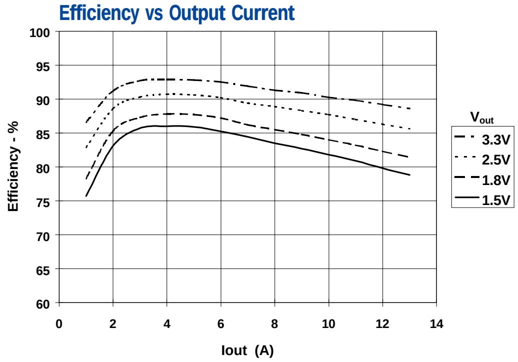
PT6700 Product Family

	Input Voltage	Vout Adjust	OVP/ Pwr Good	Requires +12V Bias
PT6701	5V	VID	✓	
PT6702	3.3V	VID	✓	
PT6705	5V	Resistor		✓
PT6715	5V	Resistor		
PT6721	12V	VID	✓	
PT6725	12V	Resistor		

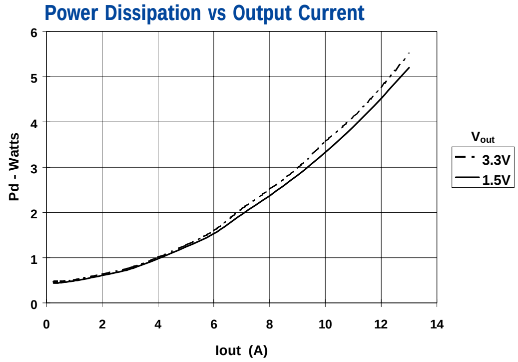
TYPICAL CHARACTERISTICS

All Models, V_{in} =5.0V *(Note A)*

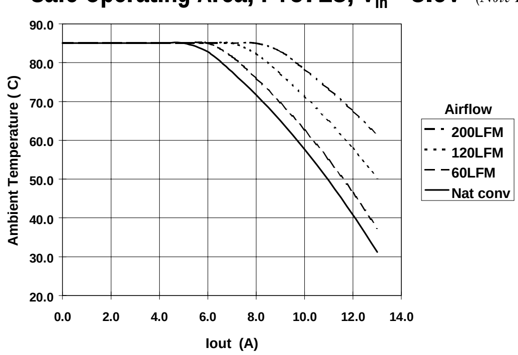
Efficiency vs Output Current



Power Dissipation vs Output Current

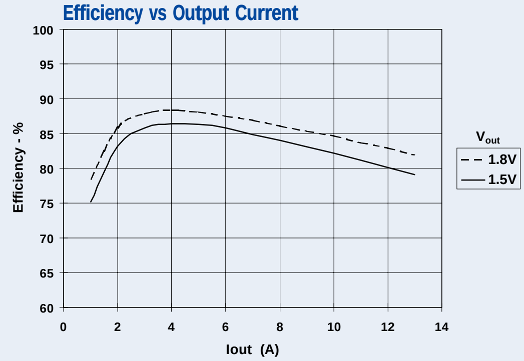


Safe Operating Area, PT6715, V_{in} =5.0V *(Note B)*

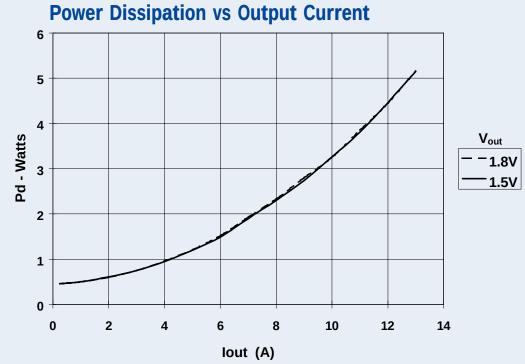


PT6717, PT6718, V_{in} =3.3V *(Note A)*

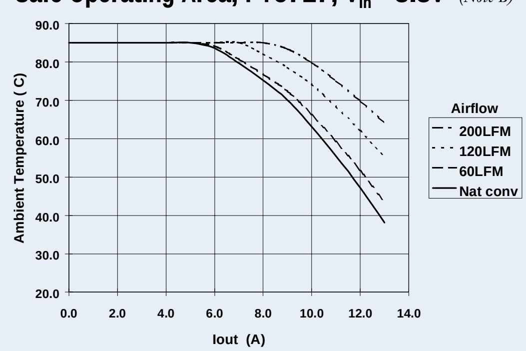
Efficiency vs Output Current



Power Dissipation vs Output Current



Safe Operating Area, PT6717, V_{in} =3.3V *(Note B)*



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

Adjusting the Output Voltage of the PT6705 and PT6715 Excalibur™ Converters

Both the PT6705 and PT6715 series ISRs are non-programmable versions of the PT6700 Excalibur™ family of converters. These regulators have a fixed output voltage, which may be adjusted higher or lower than the factory trimmed pre-set voltage using a single external resistor. Table 1 gives the allowable adjustment range for each model as V_a (min) and V_a (max).

Adjust Up: An increase in the output voltage is obtained by adding a resistor R2, between pin 1 (V_O adjust) and pin 7 (–Remote Sense).

Adjust Down: Add a resistor (R1), between pin 1 (V_O adjust) and pin 17 (+Remote Sense).

Refer to Figure 1 and Table 2 for both the placement and value of the required resistor, either (R1) or R2 as appropriate.

Notes:

1. Use only a single 1% resistor in either the (R1) or R2 location. Place the resistor as close to the ISR as possible.
2. Never connect capacitors from V_O adjust to either GND, V_{out}, or the Remote Sense pins. Any capacitance added to the V_O adjust pin will affect the stability of the ISR.
3. If the Remote Sense feature is not being used, pin 7 must be connected to pin 8 for optimum output voltage accuracy. Correspondingly the resistors (R1) and R2 may be then be connected from V_O Adjust to either V_{out} or GND respectively.
4. The PT6705 series requires a 12V external bias voltage in order to operate (see data sheet). An external bias voltage is not required for the PT6715 series.
5. Adjusting the output voltage of the PT6705 and PT6715 (3.3V models) higher than the factory pre-trimmed output voltage may require an increase in the minimum input voltage. These two models must comply with the following requirements for V_{in}(min).

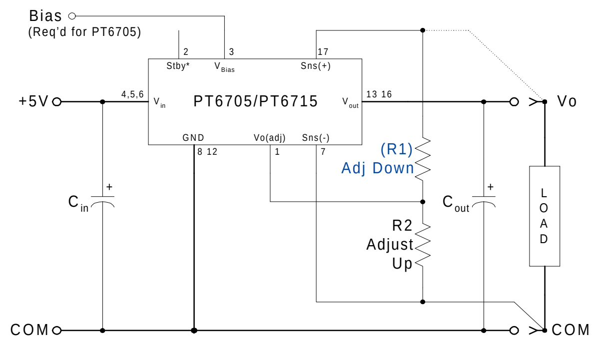
PT670x models:

$V_{in}(min) = (V_a + 1)V$

PT671x models:

$V_{in}(min) = (V_a + 1)V$ or 4.5V, whichever is greater.

Figure 1



The values of (R1) [adjust down], and R2 [adjust up], can also be calculated using the following formulas.

$$(R1) = \frac{10 \cdot (V_a - 1.27)}{(V_O - V_a)} - R_s \quad k\Omega$$

$$R2 = \frac{12.7}{V_a - V_O} - R_s \quad k\Omega$$

Where: V_o = Original output voltage
V_a = Adjusted output voltage
R_s = Series resistance value from Table 1

Table 1

PT6705/PT6715 SERIES ADJUSTMENT PARAMETERS

Series Pt #				
12V Bias (4)	**PT6708**	**PT6707**	**PT6706**	**PT6705**
No-Bias	**PT6718**	**PT6717**	**PT6716**	**PT6715**
V_O (nom)	1.5	1.8	2.5	3.3
V_a (min)	1.47	1.75	2.25	2.75
V_a (max)	1.73	2.0	2.85	3.75
R_S (kΩ)	49.9	49.9	33.2	24.9

Table 2

PT6705/PT6715 SERIES ADJUSTMENT RESISTOR VALUES

Series Pt #				
12V Bias [4]	PT6708	PT6707	PT6706	PT6705
No Bias	PT6718	PT6717	PT6716	PT6715
V_o (nom)	1.5	1.8	2.5	3.3
V_a (req'd)				
1.47	(16.8)kΩ			
1.5				
1.55	204.0kΩ			
1.6	77.1kΩ			
1.65	34.8kΩ			
1.7	13.6kΩ			
1.75		(46.1)kΩ		
1.8				
1.85		204.0kΩ		
1.9		77.1kΩ		
1.95		34.8kΩ		
2.0		13.6kΩ		
2.05				
2.1				
2.15				
2.2				
2.25			(6.0)kΩ	
2.3			(18.3)kΩ	
2.35			(38.8)kΩ	
2.4			(79.8)kΩ	
2.45			(203.0)kΩ	
2.5				
2.55			221.0kΩ	
2.6			93.8kΩ	
2.65			51.5kΩ	
2.7			30.3kΩ	
2.75			17.6kΩ	(2.0)kΩ
2.8			9.1kΩ	(5.7)kΩ
2.85			3.1kΩ	(10.2)kΩ
2.9				(15.9)kΩ
2.95				(23.1)kΩ
3.0				(32.8)kΩ
3.05				(46.3)kΩ
3.1				(66.6)kΩ
3.15				(100.0)kΩ
3.2				(168.0)kΩ
3.25				(371.0)kΩ
3.3				
3.35				229.0kΩ
3.4				102.0kΩ
3.45				59.8kΩ
3.5				38.6kΩ
3.55			Requires V_{in} > 4.5Vdc [5]	25.9kΩ
3.6				17.4kΩ
3.65				11.4kΩ
3.7				6.9kΩ
3.75				3.3kΩ

R1 = (Blue) R2 = Black