PT6725 Series

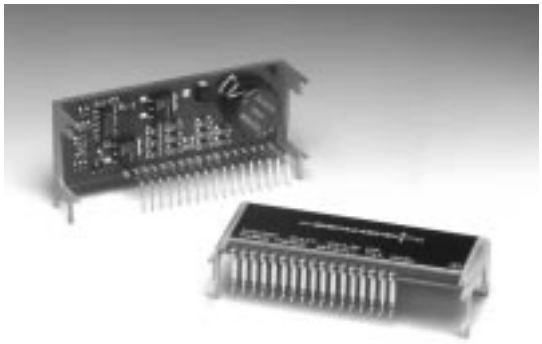
13 Amp 12V Input Adjustable Integrated Switching Regulator

EXCALIBUR

Power Trends Products from Texas Instruments

SLTS102

(Revised 6/30/2000)

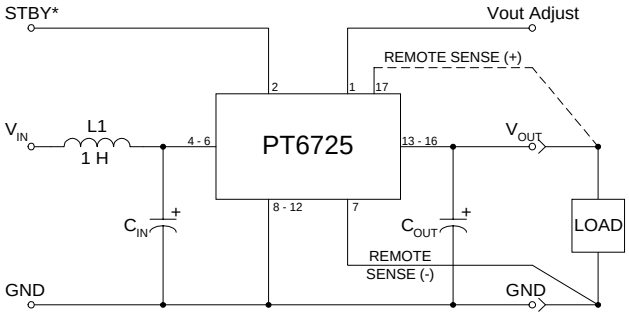


The PT6725 is a new series of high-performance, 13 Amp Integrated Switching Regulators (ISRs) housed in a unique, space-saving 17-pin SIP package. The PT6725 series operates from a standard 12V power bus to provide a high performance low-voltage power source for the industy's latest high-speed, low-voltage µPs and bus drivers.

The PT6725 series has a trimmed output voltage which may be adjusted with an external resistor. The output current is rated to 14A for output voltages of 2.5V and lower.

Other features includes a differential remote sense which allows the regulator to compensate for voltage drop between the ISR and load. This product also has 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	Pin	Function
1	V_{out} adjust	10	GND
2	STBY*	11	GND
3	Do not connect	12	GND
4	V_{in}	13	V_{out}
5	V_{in}	14	V_{out}
6	V_{in}	15	V_{out}
7	Remote Sense Gnd (4)	16	V_{out}
8	GND	17	Remote Sense V_{out}
9	GND		

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

Specifications

Characteristics (T_a = 25°C unless noted)	Symbols	Conditions		PT6725 SERIES Min	Typ	Max	Units
Output Current	$I_{o(max)}$	T_a = +60°C, 200 LFM, pkg N T_a = +25°C, natural convection	$V_o \le 2.5V$ $V_o > 2.5V$	0.1 (1) 0.1 (1)	— —	14.0 (3) 13.0 (3)	A
Input Voltage Range	V_{in}	0.1A ≤ I_o ≤ 13.0A		10.8	—	13.2	V
Output Voltage Tolerance	ΔV_o	V_{in} = 12V, I_o = 13.0A -40°C ≤ T_a ≤ +85°C		V_o-0.03	—	V_o+0.03	V
Short-Circuit Threshold	I_{sc}	V_{in} = 12V		—	20	30	A
Line Regulation	Reg_{line}	10.8V ≤ V_{in} ≤ 13.2V, I_o = 13.0A		—	±5	—	mV
Load Regulation	Reg_{load}	V_{in} = 12V, 0.1 ≤ I_o ≤ 13.0A		—	±10	—	mV
V_o Ripple/Noise	V_n	V_{in} = 12V, I_o = 13.0A		—	35	—	mV
Transient Response with C_{out} = 330µF	t_{tr} V_{os}	I_o step between 6.5A and 13A V_o over/undershoot		— —	35 70	— —	µSec mV
Efficiency	η	V_{in} = 12V, I_o = 9A	V_o = 5.0V V_o = 3.3V V_o = 2.5V V_o = 1.8V V_o = 1.5V	— — — — —	93 90 88 83 81	— — — — —	%
Switching Frequency	f_o	10.8V ≤ V_{in} ≤13.2V 0.1A ≤ I_o ≤ 13.0A		300	350	400	kHz
Absolute Maximum Operating Temperature Range	T_a	—		-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 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.

External Capacitors: *The PT6725 requires a minimum ouput capacitance of 330µF with a maximum ESR of 50mΩ@100kHz for proper operation. The maximum allowable output capacitance is 15,000µF. The input capacitance must be rated for a minimum of 1.6Arms of ripple current. For transient or dynamic load applications, additional capacitance may be required. For more information refer to the application note regarding capacitor selection for this product.*

Input Filter: *An input filter inductor is optional for most applications. The inductor must be sized to handle 6.5ADC with a typical value of 1µH.*

PT6725 Series

13 Amp 12V Input Adjustable Integrated Switching Regulator

Features

- 14A Output Current
- +12V Input
- High Efficiency
- 17-pin Space Saving Package
- Solderable Copper Case
- Adjustable Output Voltage
- Differential Remote Sense
- Short Circuit Protection

Ordering Information

PT6724❑ = 5.0 Volts
PT6725❑ = 3.3 Volts
PT6726❑ = 2.5 Volts
PT6727❑ = 1.8 Volts
PT6728❑ = 1.5 Volts

PT Series Suffix (PT1234X)

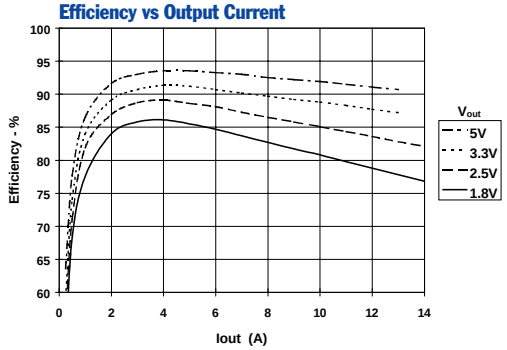
Case/Pin Configuration	
Vertical Through-Hole	**N**
Horizontal Through-Hole	**A**
Horizontal Surface Mount	**C**

(For dimensions and PC board layout, see Package Styles 1340 and 1350.)

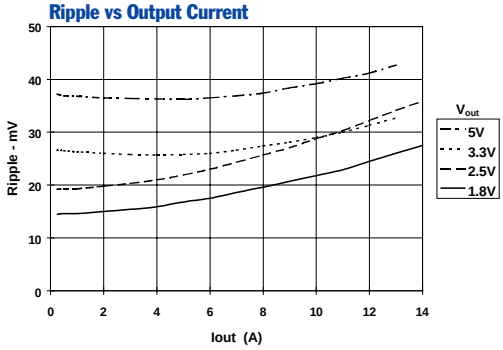
TYPICAL CHARACTERISTICS

Typical Performance, V_{in} = 12.0V *(See Foot Note A)*

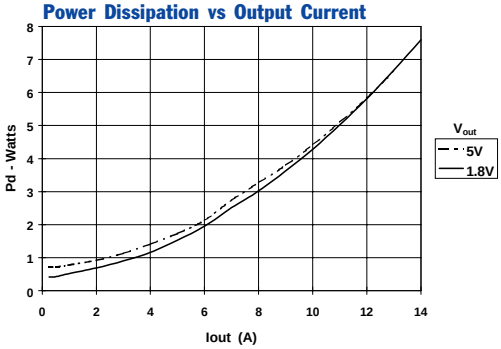
Efficiency vs Output Current



Ripple vs Output Current

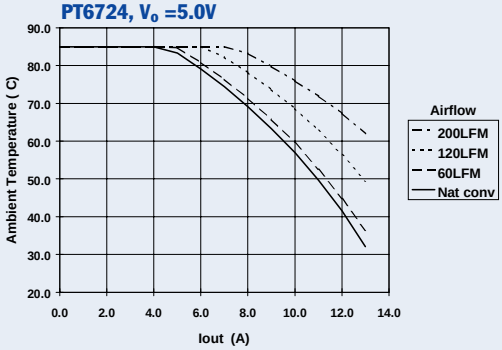


Power Dissipation vs Output Current

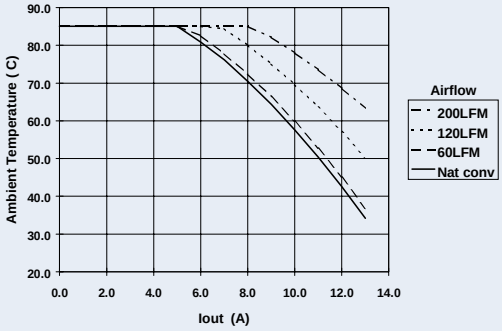


Safe Operating Area, V_{in} = 12.0V *(See Foot Note B)*

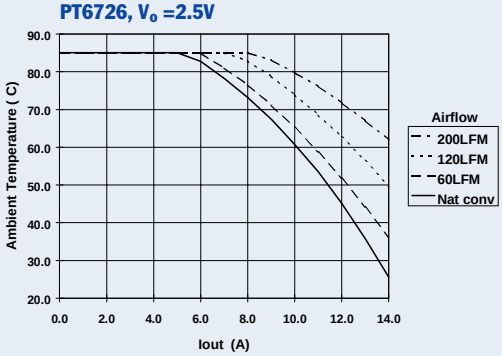
PT6724, V_o =5.0V



PT6725, V_o =3.3V



PT6726, V_o =2.5V



Note A: *All data listed 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 the conditions at which internal components are at or below manufacturer's maximum operating temperatures.*

Adjusting the Output Voltage of the PT6725 Excalibur™ Converters

The PT6725 ISRs are a non-programmable version of the PT6721, 12V input 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).

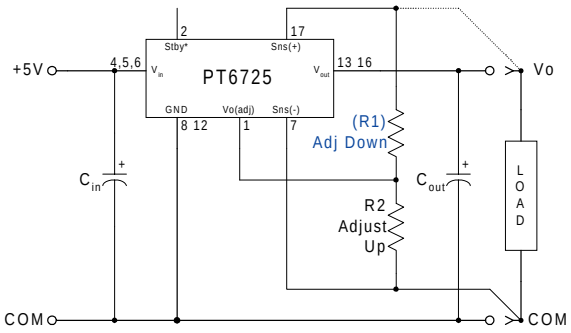
Adjust Down: Add a resistor (R1), between pin 1 (V_o adjust) and pin 17 (+Remote Sense).

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. Consequently the resistors (R1) and R2 may then be connected from V_o Adjust to either V_{out} or GND respectively.

Figure 1



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

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

$$R2 = \frac{1.27\ R_o}{V_a - V_o} - R_s \quad k\Omega$$

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

Table 1

PT6725 SERIES ADJUSTMENT PARAMETERS

Series Pt #	PT6728	PT6727	PT6726	PT6725	PT6724
V_o (nom)	1.5	1.8	2.5	3.3	5.0
V_a (min)	1.47	1.75	2.25	2.75	4.01
V_a (max)	1.73	2.0	2.85	3.75	5.47
R_o (kΩ)	10.0	10.0	10.0	10.0	9.09
R_s (kΩ)	49.9	49.9	33.2	24.9	24.9

Table 2

PT6725 SERIES ADJUSTMENT RESISTOR VALUES

Series Pt #	PT6728	PT6727	PT6726	PT6725
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				25.9kΩ
3.6				17.4kΩ
3.65				11.4kΩ
3.7				6.9kΩ
3.75				3.3kΩ

R1 = (Blue) R2 = Black

Series Pt #	PT6724
V_o (nom)	5.0
V_a (req'd)	
4.1	(3.7)kΩ
4.2	(8.4)kΩ
4.3	(14.4)kΩ
4.4	(22.5)kΩ
4.5	(33.8)kΩ
4.6	(50.8)kΩ
4.7	(79.0)kΩ
4.8	(136.0)kΩ
4.9	(305.0)kΩ
5.0	
5.1	90.5kΩ
5.2	32.8kΩ
5.3	13.6kΩ
5.4	4.0kΩ

Capacitor Recommendations for the PT6721 and PT6725 Series Regulators

Input Capacitors

The recommended input capacitance is determined by 1.6 ampere minimum ripple current rating and 1000µF minimum capacitance. Tantalum capacitors listed below cannot be used on the input bus since they are not rated for 12V operation. Ripple current and 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 50mΩ. 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 microprocessor high frequency noise components apparent during higher current excursions. Preferred low ESR type capacitor part numbers are identified in the Table 1 below.

Tantalum Characteristics

Tantalum capacitors are recommended on the output bus but only TPS Series, Sprague 593D/594/595 Series, or Kemet T495/T510 Series. The AVX TPS Series, Sprague Series or Kemet Series tantalum capacitors are recommended over other manufacturer's 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 comparing 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 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	105°C Maximum Ripple Current(Irms)	Physical Size(mm)	Input Bus	Output Bus	Vendor Number
Panasonic FC Series FA Series	35V 25V 25V	680 1000 1000	0.043Ω 0.038Ω 0.038Ω	1655mA 1655mA 1690mA	12.5x20 12.5x20 16x15	2 1 1	1 2 1	EEUFC1V681 EEUFC1E102 EEUFC1E102S
United Chemi -con LFVSeries	35V 35V 16V	680 1000 470	0.034Ω 0.038Ω 0.084Ω/2=042Ω	1690mA 1630mA 825mA x2	12.5x25 16x20 10x16	2 1 N/R(1)	1 1 2	LXV35VB680M12X25LL LXV35VB102M16X20LL LXV16VB471M10X16LL
Nichicon PL Series PM Series	35V 25V 35V	680 1200 1000	0.036Ω 0.039Ω 0.034Ω	1660mA 1600mA 1770mA	12.5x25 18x15 16x20	2 1 1	1 1 1	UPL1V681MHH UPL1E122MHH6 UPM1V102MHH6
Panasonic FC Series Surface Mtg	35V 25V 35V	1000 1000 470	0038Ω 0.038Ω 0.0430Ω	2000mA 2000mA 1690mA	18x16.5 18x16.5 16x16.5	1 1 2	1 1 1	EEVFC1V102N EEVFC1E102N EEVFC1V471N
Oscon- SS/SV Series	10V 10V	330 330	0.025Ω 0.020Ω	3500mA 3800mA	10x10.5 10.3x10.3	N/R(1) N/R(1)	1 1	10SS330M(If Output <5V) 10SV330(If Output <5V) Surface Mount(SV)
AVX Tantalum TPS Series	10V 10V	330 330	0.100Ω/2=0.050Ω 0.060Ω/2=0.030Ω	>2500mA >3000mA	7.3L x 5.7W x 4.1H	N/R(1) N/R(1)	2 2	TPSE337M010R0100 TPSV337M010R0060 Surface Mount
Kemet Tantalum T510/T495 Series	10V 10V	330 220	0.033Ω 0.070Ω/2=0.035Ω	1400mA >2000mA	4.3Wx7.3L x4.0H	N/R(1) N/R(1)	1 2	510X337M010AS T495X227M0100AS Surface Mount
Sprague Tantalum 594D Series	10V	330	0.045Ω	2360mA	7.2L x 6W x 4.1H	N/R(1)	1	594D337X0010R2T Surface Mount

Note: *(N/R) 10V tantalums are not recommend for the input bus.*

Package Style 1340

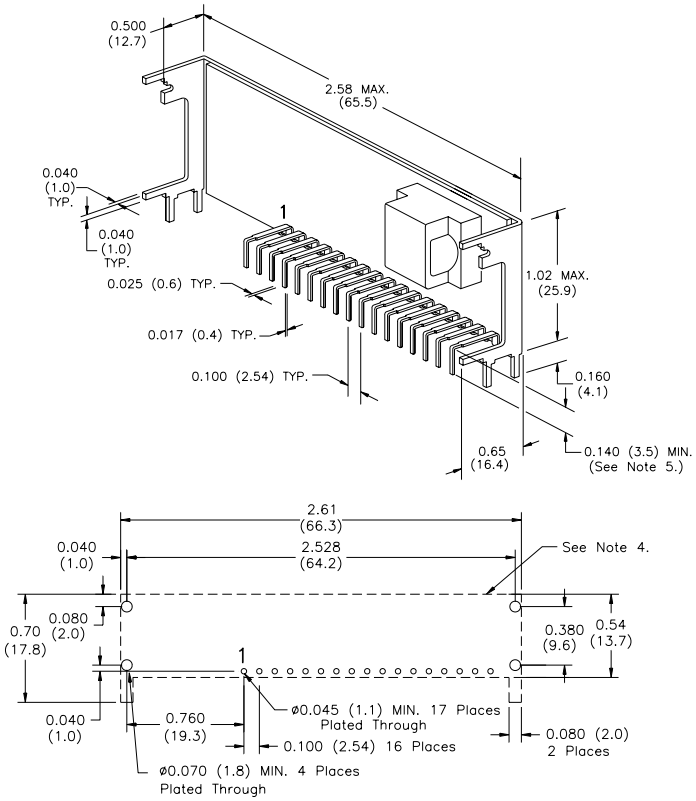
Power Trends Products from Texas Instruments

Suffix N

(Revised 6/30/2000)

PACKAGE INFORMATION AND DIMENSIONS

Vertical Through-Hole Mount (Suffix N)



PC Layout

Notes: (Rev. E)

1: All dimensions are in inches (mm).
2: 2 place decimals are ±.030 (±0.8mm).
3: 3 place decimals are ±.010 (±0.3mm).
4: Recommended mechanical keep out area (dotted line).
5: Electrical pin length mounted on printed circuit board seating plane to pin end.

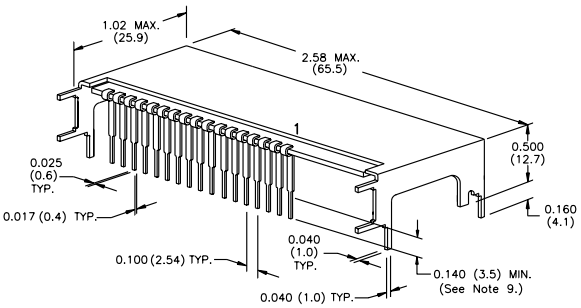
Package Style 1350

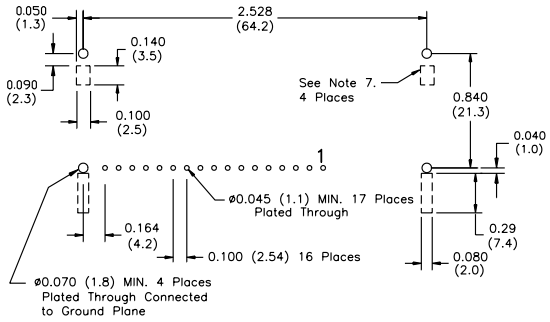
Suffix A, C

(Revised 6/30/2000)

PACKAGE INFORMATION AND DIMENSIONS

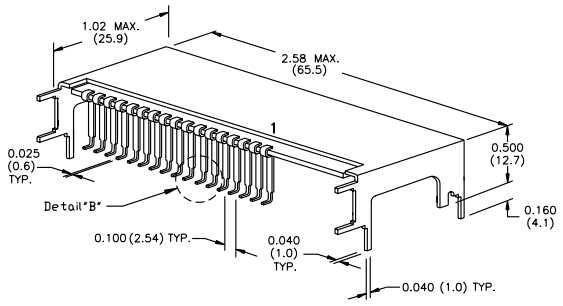
Horizontal Through–Hole Mount (Suffix A)

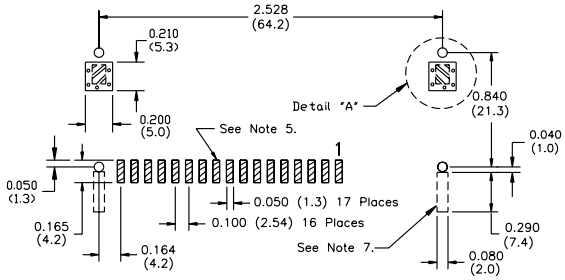




PC Layout

Horizontal Surface Mount (Suffix C)

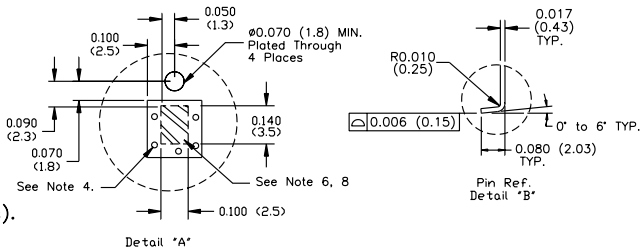




PC Layout

Notes: (Rev. E)

1: All dimensions are in inches (mm).
2: 2 place decimals are ±.030 (±0.8mm)
3: 3 place decimals are ±.010 (±0.3mm).
4: Vias are recommended to improve copper adhesion.
5: Power pin connections should utilize two or more vias per input, ground and output pin.
6: Solder mask openings to copper island for solder joints to mechanical pins.
7: Recommended mechanical keep out area (dotted lines).
8: Electrically connect case to ground plane.
9: Electrical pin length (Horizontal Through– Hole) mounted on printed circuit board seating plane to pin end.



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