30-A, 5-V Input Non-Isolated Wide-Output Adjust Power Modules

SLTS210A – MAY 2003 – REVISED MAY 2003

ADVANCE INFORMATION

NOMINAL SIZE = 1.37 in x 1.12 in (34,8 mm x 28,5 mm)

Features

- Up to 30 A Output Current
- 5-V Input Voltage
- Wide-Output Voltage Adjust (0.8 V to 3.6 V)
- Efficiencies up to 94 %
- 180 W/in³ Power Density
- On/Off Inhibit
- Output Voltage Sense
- Pre-Bias Startup
- Margin Up/Down Controls
- Auto-Track™ Sequencing
- Under-Voltage Lockout
- Output Over-Current Protection (Non-Latching, Auto-Reset)
- Over-Temperature Protection
- Surface Mountable
- Operating Temp: –40 to +85 °C
- DSP Compatible Output Voltages
- IPC Lead Free 2

Description

The PTH05030 is a series of high-current non-isolated power modules from Texas Instruments. This product is characterized by high efficiencies, and up to 30 A of output current, while occupying a mere 1.64 in² of PCB area. In terms of cost, size, and performance, the series provides OEM's with a flexible module that meets the requirements of the most complex and demanding mixed-signal applications. These include the most densly populated, multi-processor systems that incorporate high-speed DSP's, microprocessors, and ASICs.

The series uses double-sided surface mount construction and provides high-performance step-down power conversion from a 5-V input bus voltage. The output voltage of the PTH05030W can be set to any value over the range 0.8 V to 3.6 V, using a single resistor.

This series includes Auto-Track™. Auto-Track simplifies power-up and power-down supply voltage sequencing in a system by enabling modules to track each other, or any other external voltage.

Each model also includes an on/off inhibit, output voltage adjust (trim), and margin up/down controls. An output voltage sense ensures tight load regulation, and an output over-current and thermal shutdown feature provide for protection against external load faults.

Package options inlude both through-hole and surface mount connfigurations.

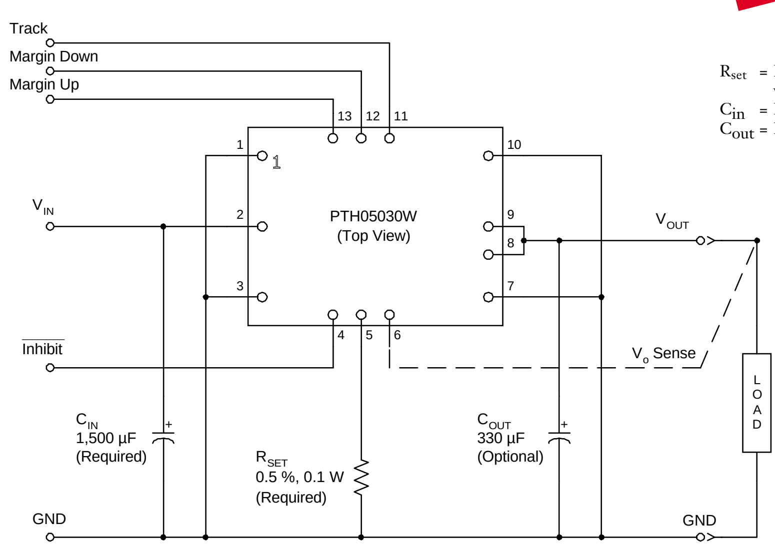
Pin Configuration

Pin	Function
1	GND
2	V_{in}
3	GND
4	Inhibit *
5	V_o Adjust
6	V_o Sense
7	GND
8	V_{out}
9	V_{out}
10	GND
11	Track
12	Margin Down *
13	Margin Up *

* *Denotes negative logic:*
Open = Normal operation
Ground = Function active

Auto-Track™ Sequencing

Standard Application



R_{set} = Resistor to set the desired output voltage (see spec. table for values).
C_{in} = Required electrolytic 1,500 µF
C_{out} = Recommended 330 µF electrolytic

TEXAS INSTRUMENTS

Ordering Information

Output Voltage (PTH05030❐xx)

Code	Voltage
W	0.8 V – 3.6 V (Adjust)

Package Options (PTH05030x❐❐) (1)

Code	Description	Pkg Ref. (2)
AH	Horiz. T/H	(EUM)
AS	SMD, Standard (3)	(EUN)

Notes: *(1) Add "T" to end of part number for tape and reel on SMD packages only.*
(2) Reference the applicable package reference drawing for the dimensions and PC board layout
(3) "Standard" option specifies 63/37, Sn/Pb pin solder material.

Pin Descriptions

GND: This is the common ground connection for the *Vin* and *Vout* power connections. It is also the 0 VDC reference for the control inputs.

Vin: The positive input voltage power node to the module, which is referenced to common *GND*.

Inhibit: The Inhibit pin is an open-collector/drain negative logic input that is referenced to *GND*. Applying a low-level ground signal to this input disables the module's output and turns off the output voltage. When the *Inhibit* control is active, the input current drawn by the regulator is significantly reduced. If the *Inhibit* pin is left open-circuit, the module will produce an output whenever a valid input source is applied.

Vo Adjust: A 0.5 %, 0.1 W resistor must be connected between this pin and the GND pin to set the output voltage to the desired value. The set point range for the output voltage is from 0.8 V to 3.6 V. The resistor required for a given output voltage may be calculated from the following formula. If left open circuit, the module output will default to its lowest output voltage value. For further information on the adjustment and/or trimming of the output voltage, consult the related application note.

$$R_{set} = 10\text{ k} \cdot \frac{0.8\text{ V}}{V_{out} - 0.8\text{ V}} - 2.49\text{ k}$$

The specification table gives the preferred resistor values for a number of standard output voltages.

Vo Sense: The sense input allows the regulation circuit to compensate for voltage drop between the module and the load. For optimal voltage accuracy *Vo Sense* should be connected to *Vout*. It can also be left disconnected.

Vout: The regulated positive power output with respect to the *GND* node.

Track: This is an analog control input that allows the output voltage to follow another voltage during power-up and power-down sequences. The pin is active from 0 V up to the nominal set-point voltage. Within this range the module's output will follow the voltage at the *Track* pin on a volt-for-volt basis. When the control voltage is raised above this range, the module regulates at its nominal output voltage. If unused, this input maybe left unconnected. For further information consult the related application note.

Margin Down: When this input is asserted to *GND*, the output voltage is decreased by 5% from the nominal. The input requires an open-collector (open-drain) interface. It is not TTL compatible. A lower percent change can be accomodated with a series resistor. For further information, consult the related application note.

Margin Up: When this input is asserted to *GND*, the output voltage is increased by 5%. The input requires an open-collector (open-drain) interface. It is not TTL compatible. The percent change can be reduced with a series resistor. For further information, consult the related application note.

ADVANCE INFORMATION

ADVANCE INFORMATION

Environmental & Absolute Maximum Ratings (Voltages are with respect to GND)

Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Track Input Voltage	V_{track}		–0.3	—	V_{in} + 0.3	V
Operating Temperature Range	T_a	Over V_{in} Range	–40	—	85	°C
Solder Reflow Temperature	T_{reflow}	Surface temperature of module body or pins			215 (i)	°C
Storage Temperature	T_s	—	–40	—	125	°C
Mechanical Shock		Per Mil-STD-883D, Method 2002.3 1 msec, ½ Sine, mounted	—	TBD	—	G's
Mechanical Vibration		Mil-STD-883D, Method 2007.2 20-2000 Hz	—	TBD	—	G's
Weight	—		—	5	—	grams
Flammability	—	Meets UL 94V-O				

Notes: (i) *During reflow of SMD package version do not elevate peak temperature of the module, pins or internal components above the stated maximum. For further guidance refer to the application note, "Reflow Soldering Requirements for Plug-in Power Surface Mount Products."*

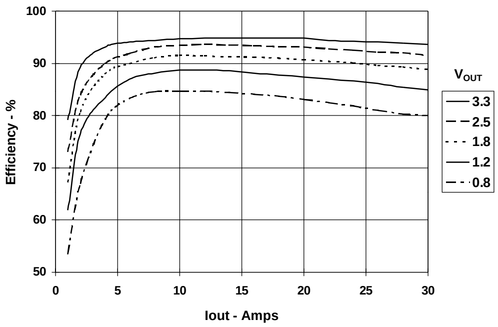
Specifications (Unless otherwise stated, T_a =25 °C, V_{in} =5 V, V_{out} =3.3 V, C_{in} =1,500 µF, C_{out} =0 µF, and I_o =$I_o$max)

			PTH05030W			
Characteristics	**Symbols**	**Conditions**	**Min**	**Typ**	**Max**	**Units**
Output Current	I_o	60 °C, 200 LFM airflow 25 °C, natural convection	0 0	— —	30 (1) 30 (1)	A
Input Voltage Range	V_{in}	Over I_o range	4.5	—	5.5	V
Set-Point Voltage Tolerance	V_o tol		—	—	±2	%V_o
Temperature Variation	ΔReg_{temp}	–40 °C < T_a < +85 °C	—	±0.5	—	%V_o
Line Regulation	ΔReg_{line}	Over V_{in} range	—	±10	—	mV
Load Regulation	ΔReg_{load}	Over I_o range	—	±12	—	mV
Total Output Variation	ΔReg_{tot}	Includes set-point, line, load, –40 °C ≤ T_a ≤ +85 °C	—	—	±3	%V_o
Efficiency	η	I_o =20 A R_{SET} = 698 Ω V_o = 3.3 V R_{SET} = 2.21 kΩ V_o = 2.5 V R_{SET} = 4.12 kΩ V_o = 2.0 V R_{SET} = 5.49 kΩ V_o = 1.8 V R_{SET} = 8.87 kΩ V_o = 1.5 V R_{SET} = 17.4 kΩ V_o = 1.2 V R_{SET} = 36.5 kΩ V_o = 1.0 V	— — — — — — —	94 93 91 90 89 87 86	— — — — — — —	%
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth	—	40	—	mVpp
Over-Current Threshold	I_o trip	Reset, followed by auto-recovery	—	47	—	A
Transient Response	t_{tr} ΔV_{tr}	1 A/µs load step, 50 to 100 % $I_o$max, C_{out} =330 µF Recovery Time V_o over/undershoot	— —	70 100	— —	µSec mV
Margin Up/Down Adjust	V_o adj		—	± 5	—	%
Margin Input Current (pins 12 /13)	I_{IL} margin	Pin to GND	—	– 8 (2)	—	µA
Track Input Current (pin 11)	I_{IL} track	Pin to GND	—	—	–130 (3)	µA
Track Slew Rate Capability	dV_{track}/dt	$\lvert V_{track} - V_o \rvert \leq$ 50 mV and $V_{track} < V_o$(nom)	5	—	—	V/ms
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— TBD	4.35 3	TBD —	V
Inhibit Control (pin4) Input High Voltage Input Low Voltage	 V_{IH} V_{IL}	Referenced to GND	 V_{in} –0.5 –0.2	 — —	 Open (3) 0.8	V
Input Low Current	I_{IL} inhibit	Pin to GND	—	–130	—	µA
Input Standby Current	I_{in} inh	Inhibit (pin 4) to GND, Track (pin 11) open	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	275	300	235	kHz
External Input Capacitance	C_{in}		1,500 (4)	—	—	µF
External Output Capacitance	C_{out}		0	330 (5)	TBD	µF
Reliability	MTBF	Per Bellcore TR-332 50 % stress, T_a =40 °C, ground benign	TBD	—	—	10^6 Hrs

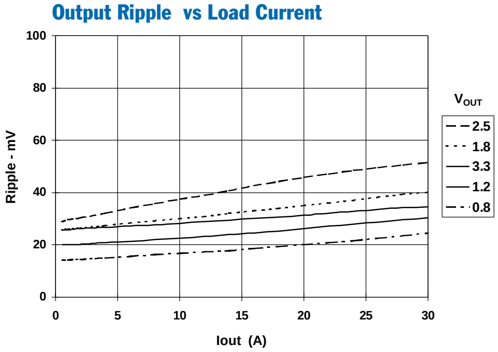
Notes: (1) *See SOA curves or consult factory for appropriate derating.*
(2) *A small low-leakage (<100 nA) MOSFET is recommended to control this pin. The open-circuit voltage is less than 1 Vdc.*
(3) *This control pin has an internal pull-up to the input voltage Vin. If it is left open-circuit the module will operate when input power is applied. A small low-leakage (<100 nA) MOSFET is recommended for control. For further information, consult the related application note.*
(4) *A 1,500 µF electrolytic input capacitor is required for proper operation. The capacitor must be rated for a minimum of 900 mA rms of ripple current.*
(5) *An external output capacitor is not required for basic operation. Adding 330 µF of distributed capacitance at the load will improve the transient response.*

Characteristic Data; V_{in} =5 V *(See Note A)*

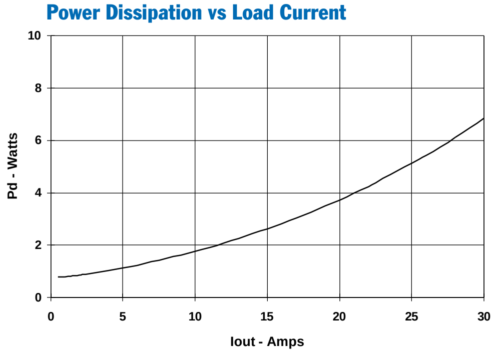
Efficiency vs Load Current



Output Ripple vs Load Current

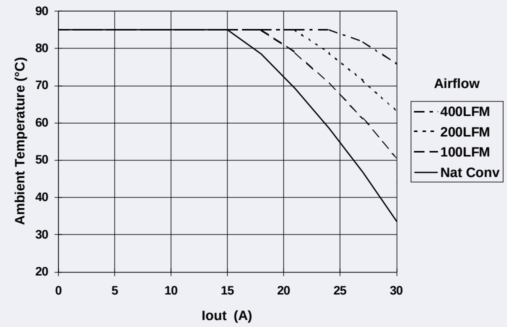


Power Dissipation vs Load Current



Safe Operating Area; V_{in} =5 V *(See Note B)*

Output Voltage =3.3 V



ADVANCE INFORMATION

The products listed hereunder are prototype or pre-production devices which have not been fully qualified to Texas Instrument's specifications. Product specifications are subject to change without notice. Texas Instruments makes no warranty, either expressed, implied, or statutory, including implied warranty of merchantability or fitness for a specific purpose, of these products.

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. Derating limits apply to modules soldered directly to a 4 in. × 4 in. double-sided PCB with 1 oz. copper.*

Capacitor Recommendations for the PTH03030 & PTH05030 Series of Power Modules

Input Capacitor

The recommended input capacitance is determined by 900 mA rms minimum ripple current rating and 1500 µF minimum capacitance.

Ripple current and <100 mΩ equivalent series resistance (ESR) values are the major considerations, along with temperature, when designing with different types of capacitors. Tantalum capacitors have a recommended minimum voltage rating of twice 2 × (the maximum DC voltage + AC ripple). This is necessary to insure reliability for input voltage bus applications.

Output Capacitors (Optional)

The ESR of the capacitors is less than or equal to 150 mΩ. Electrolytic capacitors have marginal ripple performance at frequencies greater than 400 kHz but excellent low frequency transient response. Above the ripple frequency, ceramic 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 2-1.

Tantalum Capacitors

Tantalum type capacitors can be used for the output but only the AVX TPS, Sprague 593D/594/595 or Kemet T495/T510 series. These capacitors are recommended over many other tantalum 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 has considerably higher ESR, reduced power dissipation, and lower ripple current capability. The TAJ series is less reliable than the AVX TPS series when determining power dissipation capability. Tantalum or Oscon® types are recommended for applications where ambient temperatures fall below 0 °C.

Ceramic Capacitors

Electrolytic capacitors may be substituted with ceramic types, with the minimum capacitance value, for improved ripple reduction on both the input and output bus.

Capacitor Table

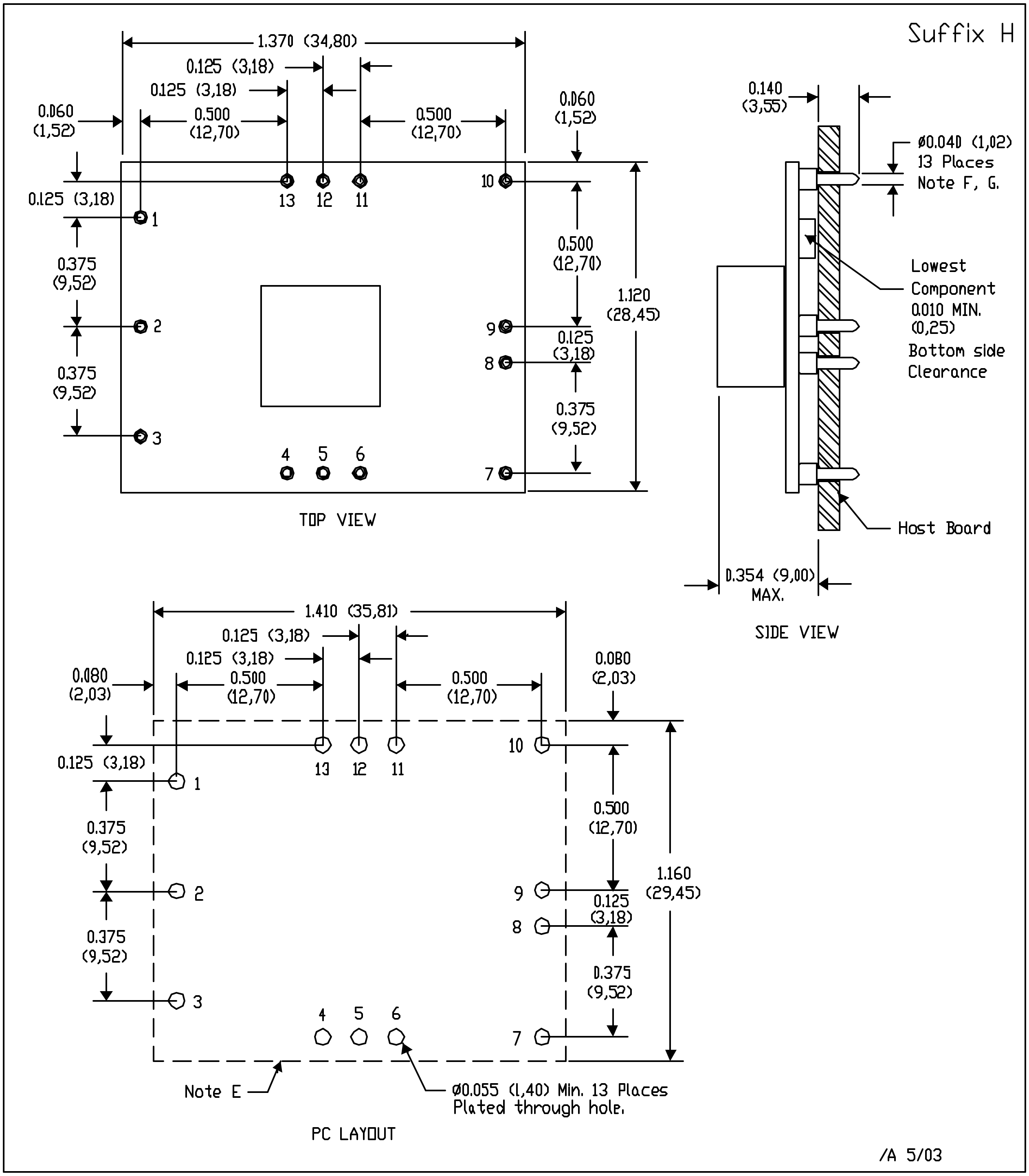
Table 2-1 identifies the characteristics of capacitors from a number of vendors with acceptable ESR and ripple current (rms) ratings. The number of capacitors required at both the input and output buses is identified for each capacitor type.

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 (at 100kHz) are the critical parameters necessary to insure both optimum regulator performance and long capacitor life.

Table 2-1: Input/Output Capacitors

Capacitor Vendor/ Series	Capacitor Characteristics					Quantity		
	Working Voltage	Value(µF)	(ESR) Equivalent Series Resistance	105°C Maximum Ripple Current(I rms)	Physical Size(mm)	Input Bus	Output Bus	Vendor Part Number
Panasonic	10 V	560	0.090 Ω ÷3	>900 mA	10×12.5	3	1	EEUFC1A561
FC (Radial)	10 V	2200	0.060 Ω	1100 mA	12.5×13.5	1	1	EEVFK1A222Q
FK (Surface Mt.)	16 V	1500	0.043 Ω	1690 mA	10×16	1	1	EEUFC1C152S
	16 V	1500	0060 Ω	1100 mA	12.5×13.5	1	1	EEVFK1C152Q
United Chemi-con	6.3 V	1000	0.013 Ω ÷2	>4935 mA	10×10.5	2	1	6FX1000M
FX	6.3 V	470	0.013 Ω ÷3	>4130 mA	10×7.7	3	1	PXA6.3VC471MJ80TP
PXA (Surface Mt.)	10 V	680	0.090 Ω ÷3	>900 mA	10×12.5	3	1	LXZ10VB681M10X12LL
LXZ Series	10 V	1000	0.068 Ω ÷2	>1050 mA	10×16	2	1	LXZ10VB102M10X16LL
Nichicon	6.3 V	470	0.020 Ω ÷3	>4130mA	10×10	3	1	PNA1A471M1
NA	10 V	470	0.018 Ω ÷2	>4400 mA	10×8	3	1	PNX0J471MCAR1GS
NX (Surface Mt.)	10 V	1500	0.050 Ω	1330 mA	16×15	1	1	UPM1A152MHH6
PM Series	16 V	1500	0.041 Ω	1560 mA	18×15	1	1	UPM1C152MHH6
Sanyo-Os-con:								
SP	10 V	470	0.015 Ω ÷3	>4500 mA	10×10.5	3	1	10SP470M
SVP (Surface Mt.)	10 V	560	0.013 Ω ÷3	>5200 mA	10×12.7	3	1	10SVP560M
AVX Tantalum	10 V	470	0.045 Ω ÷3	>1723 mA	7.3L	3	1	TPSE477M010R0045
TPS (Surface Mt.)	10 V	470	0.060 Ω ÷3	>1826 mA	×5.7W	3	1	TPSV477M010R0060
					×4.1H			
Kemet Polymer	10 V	330	0.040 Ω	>1800 mA	4.3W	5	1	T520X337M010AS
Tantalum	10 V	330	0.015 Ω	>3800 mA	×7.3L	5	1	T530X337M010AS
T520/T530 Series					×4.0H			
(Surface Mt.)								
Sprague Tantalum	10 V	470	0.100 Ω	1440 mA	7.2L	3	1	595D477X0010R2T
595D Series					×6W			
(Surface Mt.)					×4.1H			

EUM (R-PDSS-T13) DOUBLE SIDED MODULE



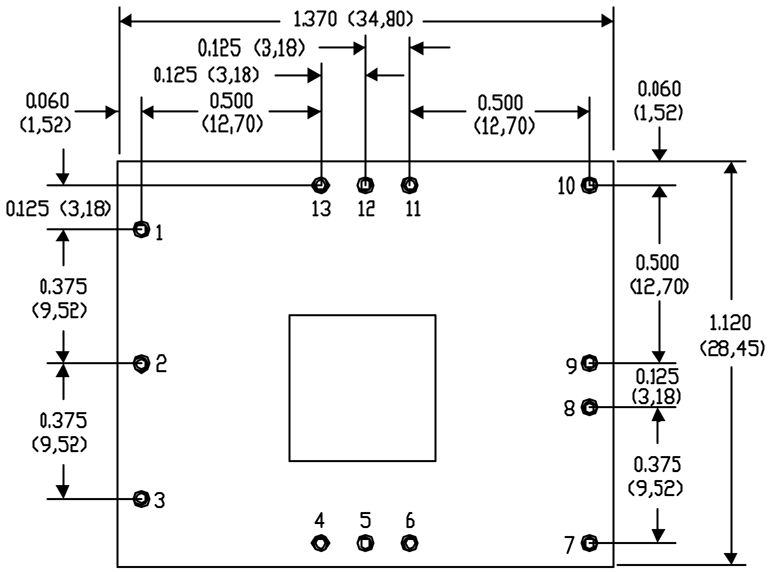
NOTES:

A. All linear dimensions are in inches (mm).
B. This drawing is subject to change without notice.
C. 2 place decimals are ±0.030 (±0,76mm).
D. 3 place decimals are ±0.010 (±0,25mm).
E. Recommended keep out area for user components.
F. Pins are 0.040″ (1,02) diameter with 0.070″ (1,78) diameter standoff shoulder.
G. All pins: Material – Copper Alloy
Finish – Tin (100%) over Nickel plate

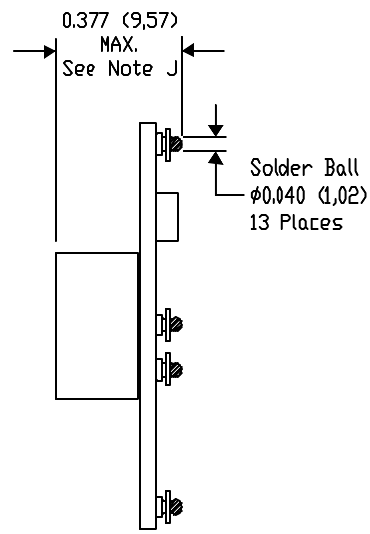
SCALE	SIZE		REV	SHEET
2X				2/3

EUN (R-PDSS-B13) DOUBLE SIDED MODULE

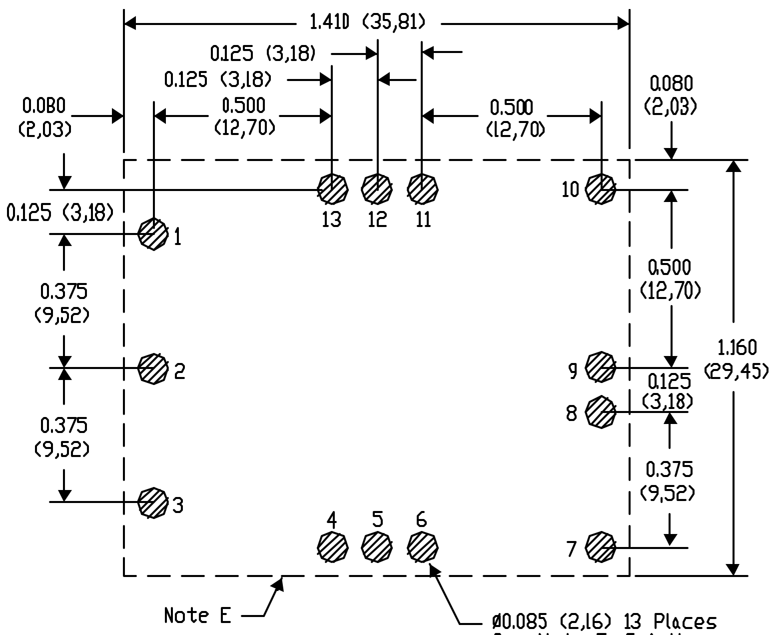
Suffix S



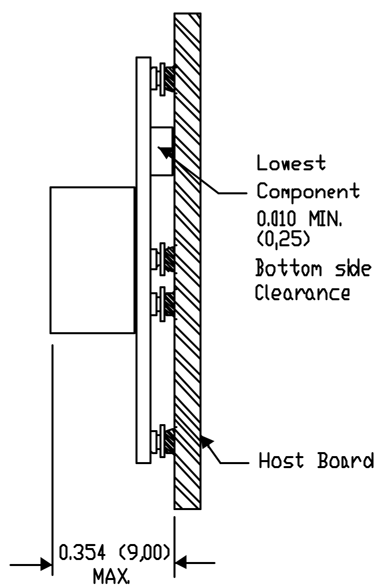
TOP VIEW



SIDE VIEW



PC LAYOUT



/A 5/03

NOTES:
- A. All linear dimensions are in inches (mm).
- B. This drawing is subject to change without notice.
- C. 2 place decimals are ±0.030 (±0,76mm).
- D. 3 place decimals are ±0.010 (±0,25mm).
- E. Recommended keep out area for user components.
- F. Power pin connection should utilize two or more vias to the interior power plane of 0.025 (0,63) I.D. per input, ground and output pin (or the electrical equivalent).
- G. Paste screen opening: 0.080 (2,03) to 0.085 (2,16). Paste screen thickness: 0.006 (0,15).
- H. Pad type: Solder mask defined.
- I. All pins: Material - Copper Alloy
  Finish - Tin (100%) over Nickel plate
  Solder Ball - See product data sheet.
- J. Dimension prior to reflow solder.

SCALE	SIZE		REV	SHEET
2X				2 / 3

IMPORTANT NOTICE

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