



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

Features

- Up to 26 A Output Current
- 12-V Input Voltage
- Wide-Output Voltage Adjust (1.2 V to 5.5 V)
- Efficiencies up to 94 %
- 235 W/in³ Power Density
- On/Off Inhibit
- Output Voltage Sense
- Pre-Bias Startup
- Margin Up/Down Controls
- Auto-Track™ Sequencing
- Dual-Phase Topology
- 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 PTH12030 is a series of high-current non-isolated power module from Texas Instruments. This product is characterized by high efficiencies, and up to 26 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 densely 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 12-V input bus voltage. The out-

put voltage of the PTH12030W can be set to any value over the range, 1.2 V to 5.5 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 include both through-hole and surface mount configurations.

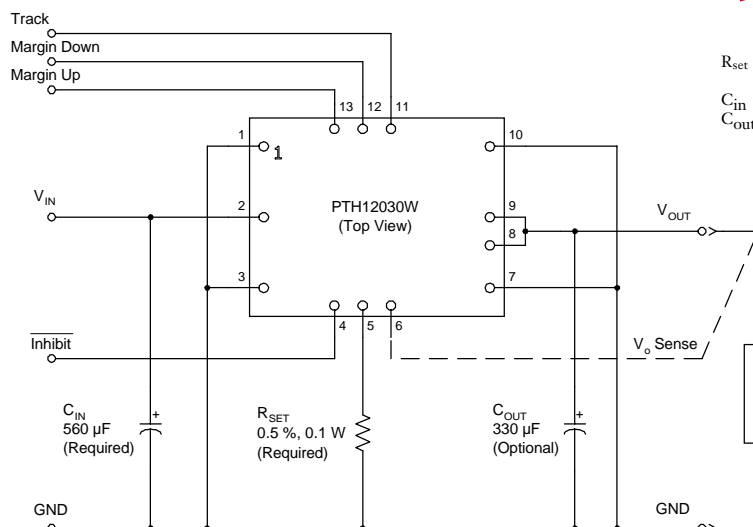
Pin Configuration

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 560 µF
C_{out} = Optional 330 µF electrolytic

Ordering Information

Output Voltage (PTH12030□xx)		Package Options (PTH12030x□□) ⁽¹⁾		
Code	Voltage	Code	Description	Pkg Ref. ⁽²⁾
W	1.2 V – 5.5 V (Adjust)	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 V_{in} and V_{out} 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 1.2 V to 5.5 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.

$$R_{set} = 10\text{ k} \cdot \frac{0.8\text{ V}}{V_{out} - 1.2\text{ V}} - 1.82\text{ k}$$

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 V_o Sense should be connected to V_{out} . 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. Alternatively, it can be connected to V_{in} for a faster power-up. 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 accommodated 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.

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

Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Signal Input Voltages		Track control (pin 11) Inhibit control (pin 4)	–0.3 –0.3	— —	$V_{in} + 0.3$ 5	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 (1)	°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	—	—	—	7	—	grams
Flammability	—	Meets UL 94V-O	—	—	—	—

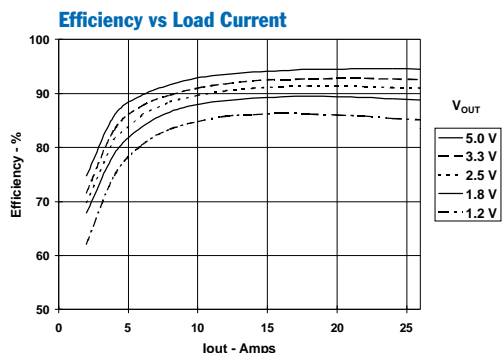
Notes: (i) During reflow of SMD package version do not elevate peak temperature of the module, pins or internal components above the stated maximum. For further guidance refer to the application note, "Reflow Soldering Requirements for Plug-in Power Surface Mount Products."

Specifications (Unless otherwise stated, $T_a = 25^\circ\text{C}$, $V_{in} = 12\text{ V}$, $V_{out} = 3.3\text{ V}$, $C_{in} = 560\text{ }\mu\text{F}$, $C_{out} = 0\text{ }\mu\text{F}$, and $I_o = I_{o,max}$)

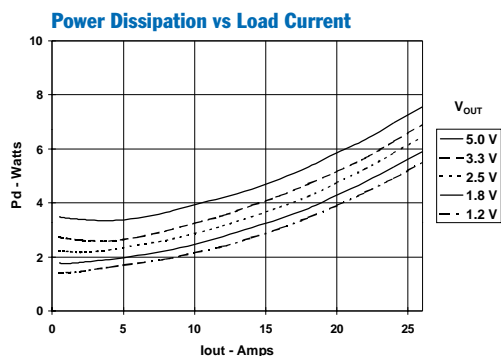
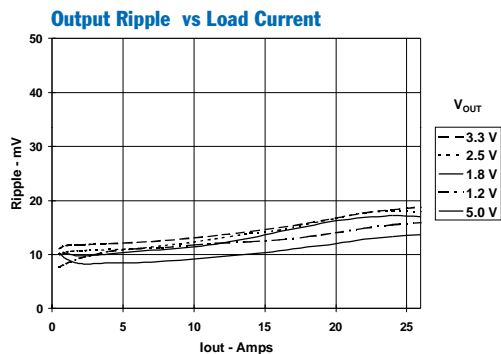
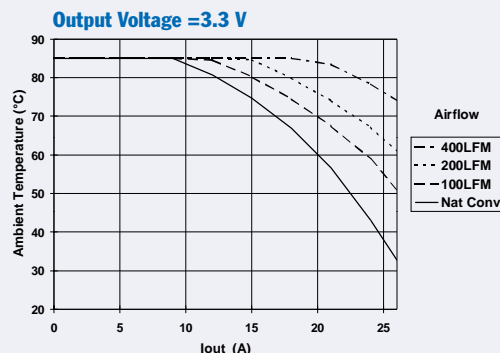
Characteristics	Symbols	Conditions	PTH12030W			Units
			Min	Typ	Max	
Output Current	I_o	60 °C, 200 LFM airflow 25 °C, natural convection	0 0	— —	26 (1) 26 (1)	A
Input Voltage Range	V_{in}	Over I_o range	10.2	—	13.8	V
Set-Point Voltage Tolerance	$V_o\text{ tol}$	—	—	—	±2	% V_o
Temperature Variation	ΔReg_{temp}	–40 °C < T_a < +85 °C	—	±0.5	—	% V_o
Line Regulation	ΔReg_{line}	Over V_{in} range	—	±5	—	mV
Load Regulation	ΔReg_{load}	Over I_o range	—	±5	—	mV
Total Output Variation	ΔReg_{tot}	Includes set-point, line, load, –40 °C ≤ T_a ≤ +85 °C	—	—	±3	% V_o
Efficiency	η	$I_o = 18\text{ A}$ RSET = 280 Ω $V_o = 5.0\text{ V}$ RSET = 2.0 kΩ $V_o = 3.3\text{ V}$ RSET = 4.32 kΩ $V_o = 2.5\text{ V}$ RSET = 8.06 kΩ $V_o = 2.0\text{ V}$ RSET = 11.5 kΩ $V_o = 1.8\text{ V}$ RSET = 24.3 kΩ $V_o = 1.5\text{ V}$ RSET = open cct. $V_o = 1.2\text{ V}$	— — — — — — —	94.5 92.7 91.4 90.3 89.5 88.2 86.2	— — — — — — —	%
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth $V_o \leq 2.5\text{ V}$ $V_o > 2.5\text{ V}$	— —	25 1	— —	mVpp % V_o
Over-Current Threshold	$I_o\text{ trip}$	Reset, followed by auto-recovery	—	40	—	A
Transient Response	t_{tr} ΔV_{tr}	1 A/μs load step, 50 to 100 % $I_{o,max}$, $C_{out} = 330\text{ }\mu\text{F}$ Recovery Time V_o over/undershoot	— —	50 150	— —	μSec mV
Margin Up Down Adjust	$V_o\text{ adj}$	With V_o Adjust control	—	± 5	—	%
Margin Input Current (pins 12 /13)	$I_{IL\text{ margin}}$	Pin to GND	—	– 8 (2)	—	μA
Track Input Current (pin 11)	$I_{IL\text{ track}}$	Pin to GND	—	—	–0.13 (2)	mA
Track Slew Rate Capability	dV_{track}/dt	$ V_{track} - V_o \leq 50\text{ mV}$ and $V_{track} < V_o(\text{nom})$	5	—	—	V/ms
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— 8	9.5 8.5	10 —	V
Inhibit Control (pin4) Input High Voltage Input Low Voltage Input Low Current	V_{IH} V_{IL} $I_{IL\text{ inhibit}}$	Referenced to GND Pin to GND	2.5 –0.2 —	— — –0.5	Open (3) 0.5 —	V mA
Input Standby Current	$I_{in\text{ inh}}$	Inhibit (pin 4) to GND, Track (pin 11) open	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	—	500	—	kHz
External Input Capacitance	C_{in}	—	560 (4)	—	—	μF
External Output Capacitance	C_{out}	—	0	330 (5)	TBD	μF
Reliability	MTBF	Per Bellcore TR-332 50 % stress, $T_a = 40^\circ\text{C}$, 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 5 V nominal. 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 560 μF electrolytic input capacitor is required for proper operation. The capacitor must be rated for a minimum of 500 mArms 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; $V_{in} = 12\text{ V}$ (See Note A)



Safe Operating Area; $V_{in} = 12\text{ V}$ (See Note B)



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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 PTH12030 Series of Power Modules

Input Capacitor

The recommended input capacitance is determined by 500 mArms minimum ripple current rating and 560 μ F minimum capacitance.

Ripple current and <100 m Ω 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, $2 \times$ (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 m Ω . 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 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 critical parameters necessary to insure both optimum regulator performance and long capacitor life.

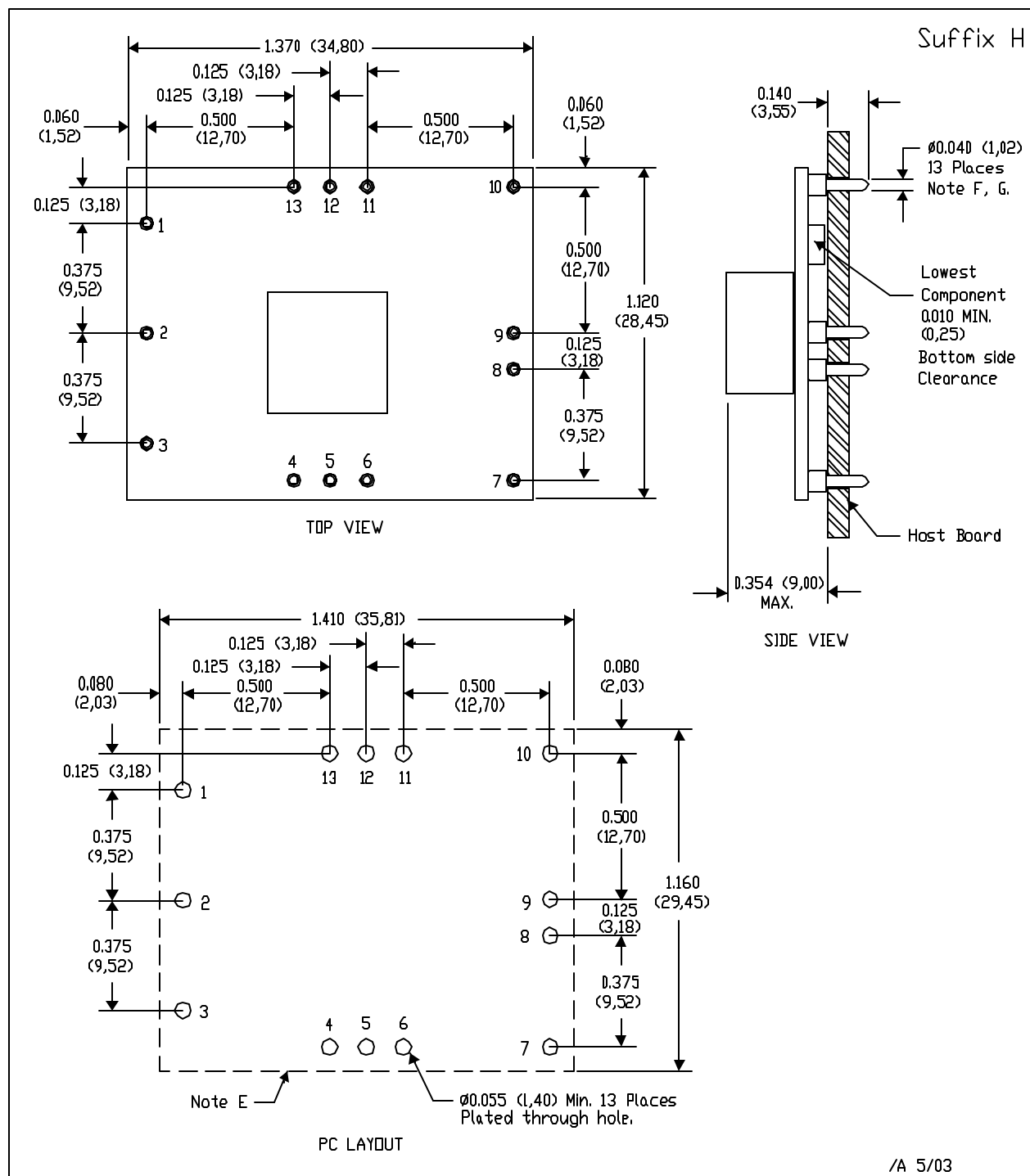
Table 1: Input/Output Capacitors

Capacitor Vendor/ Series	Capacitor Characteristics					Quantity		Vendor Part Number
	Working Voltage	Value (μ F)	(ESR) Equivalent Series Resistance	Max Ripple Current @105 °C (Irms)	Physical Size(mm)	Input Bus	Optional Output Bus	
Panasonic FC (Radial) FK (Surface Mt)	25 V	330	0.090 Ω	755 mA	10x12.5	2	1	EEUFC1E331
	25 V	560	0.065 Ω	1205 mA	12.5x15	1	1	EEUFC1E561S
	25 V	470	0.080 Ω	850 mA	10x10.2	2	1	EEVFK1E471P
	35 V	680	0.060 Ω	1100 mA	12.5x13.5	1	1	EEVFK1V681Q
United Chemi-Con FX Series LXZ Series	16 V	330	0.018 Ω	4500 mA	10x10.5	2	1	16FX330M
	16 V	330	0.090 Ω	760 mA	10x12.5	2	1	LXZ25VB331M10X12LL
	16 V	680	0.068 Ω	1050 mA	10x16	1	1	LXZ16VB681M10X16LL
Nichicon PM Series	16 V	330	0.12/2 Ω	900 mA	10x12.5	2	1	UPM1C331MPH6
	25 V	560	0.060 Ω	1060 mA	12.5x15	1	1	UPM1E561MHH6
	35 V	560	0.048 Ω	1360 mA	16x15	1	1	UPM1V561MHH6
Os-con SP SVP (Surface Mt)	16 V	270	0.018 Ω	>3500 mA	10x10.5	2	1	16SP270M
	16 V	330	0.016 Ω	4700 mA	11x12	2	1	16SVP330M
AVX Tantalum TPS (Surface Mt)	10 V	330	0.1 Ω	>2500 mA	7.3L	N/R (1)	1	TPSE337M010R0100 ($V_{oc} \leq 5.1V$)
	10 V	330	0.06 Ω	>3000 mA	x5.7W x4.1H	N/R (1)	1	TPSV337M010R0060 ($V_{oc} \leq 5.1V$)
Kemet Tantalum T520/T495 Series (Surface Mt)	10 V	330	0.040 Ω	1600 mA	4.3W	N/R (1)	1	520X337M010AS ($V_{oc} \leq 5.1V$)
	10 V	220	0.07 Ω	>2000 mA	x7.3L x4.0H	N/R (1)	1	T495X227M0100AS ($V_{oc} \leq 5.1V$)
Sprague Tantalum 594D Series (Surface Mt)	10 V	330	0.045 Ω	2360 mA	7.2L x6W x4.1H	N/R (1)	1	594D337X0010R2T ($V_{oc} \leq 5.1V$)

(1) N/R - Not recommended. The voltage rating does not meet the minimum operating limits.

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 ($\pm 0,76$ mm).
 - D. 3 place decimals are ± 0.010 ($\pm 0,25$ mm).
 - 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 pths: Material - Copper Alloy
Finish - Tin (100%) over Nickel plate

SCALE
2X

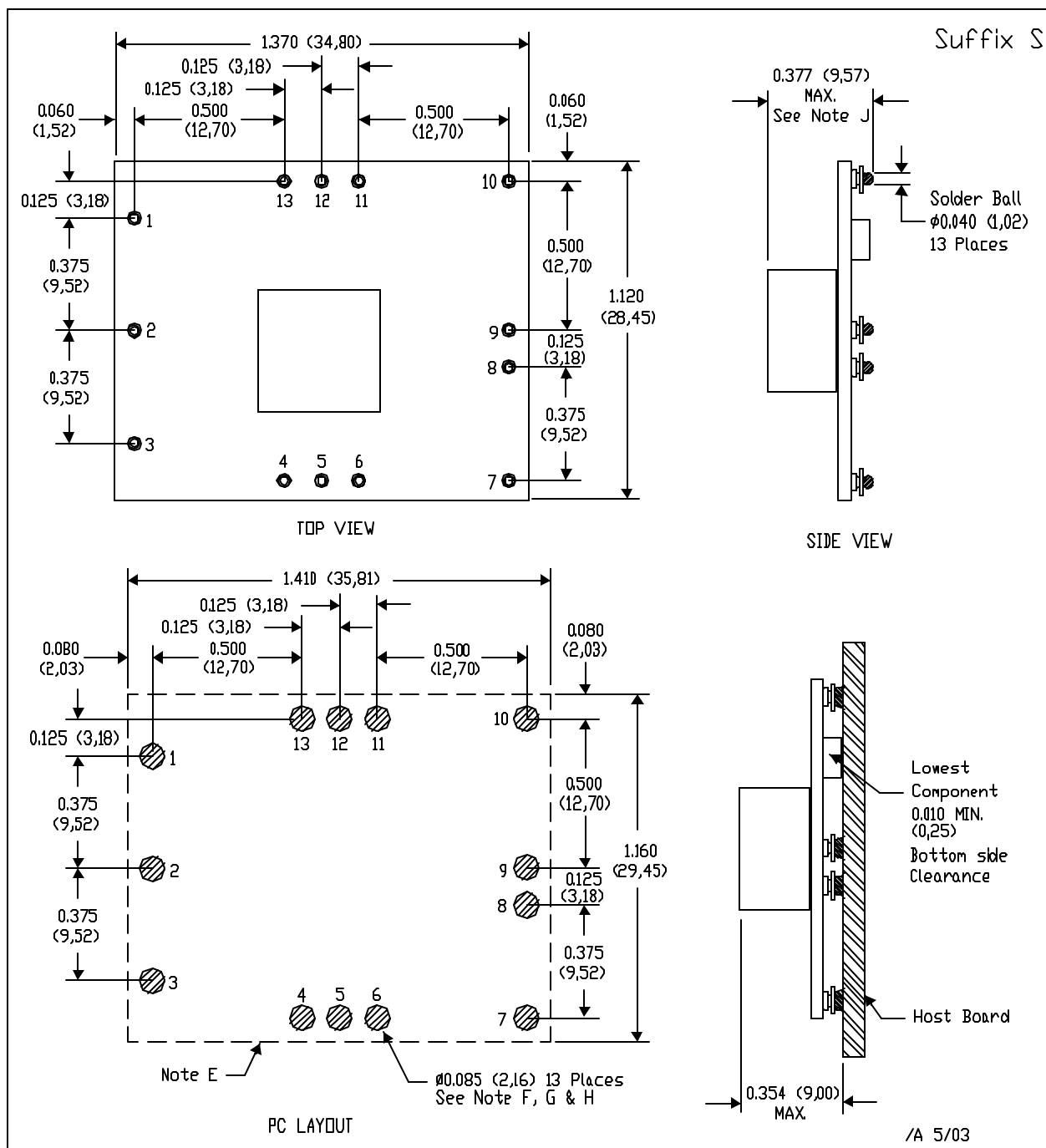
SIZE

REV

SHEET
2
3

EUN (R-PDSS-B13)

DOUBLE SIDED MODULE



- NOTES:
- All linear dimensions are in inches (mm).
 - This drawing is subject to change without notice.
 - 2 place decimals are ± 0.030 ($\pm 0,76$ mm).
 - 3 place decimals are ± 0.010 ($\pm 0,25$ mm).
 - Recommended keep out area for user components.
 - 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).

- Paste screen opening: 0.080 (2,03) to 0.085 (2,16). Paste screen thickness: 0.006 (0,15).
- Pad type: Solder mask defined.
- All pins: Material - Copper Alloy
Finish - Tin (100%) over Nickel plate
Solder Ball - See product data sheet.
- Dimension prior to reflow solder.

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