22-A, 3.3-V Input Non-Isolated Wide-Output Adjust Power Module

SLTS206A – MAY 2003 – REVISED MAY 2003

NOMINAL SIZE = 1.5 in x 0.87 in (38,1 mm x 22,1 mm)

Features

- Up to 22-A Output Current
- 3.3-V Input Voltage
- Wide-Output Voltage Adjust (0.8 V to 2.5 V)
- Efficiencies up to 93 %
- 120 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

ADVANCE INFORMATION

Description

The PTH03020 series of non-isolated power modules offers OEM designers a combination of high performance, small footprint, and industry leading features. As part of a new class of power modules these products provide designers with the flexibility to power the most complex multi-processor digital systems using off-the-shelf catalog parts.

The series employs double-sided surface mount construction and provides high-performance step-down power conversion for up to 22 A of output current from a 3.3-V input bus voltage. The output voltage of the PTH03020W can be set to any value over the range, 0.8 V to 2.5 V, using a single resistor.

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

Other operating features include an on/off inhibit, output voltage adjust (trim), and margin up/down controls. To ensure tight load regulation, an output voltage sense is also provided. A non-latching over-current trip and over-tempterature shutdown provide load fault protection.

Target applications include complex multi-voltage, multi-processor systems that incorporate the industry's high-speed DSPs, micro-processors and bus drivers.

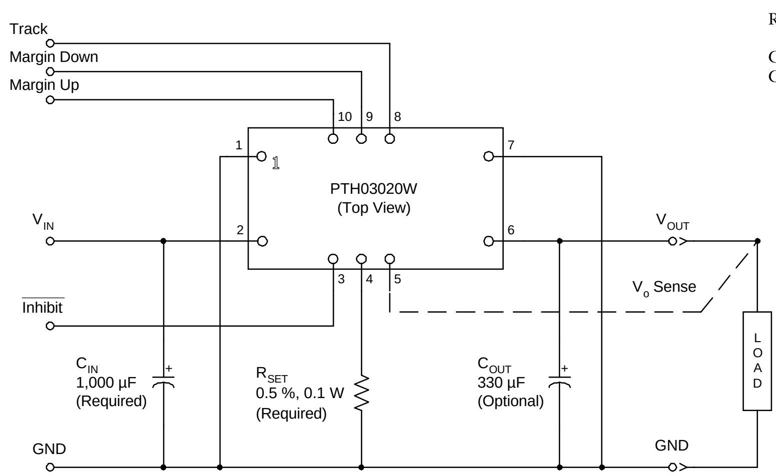
Pin Configuration

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

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

Auto-Track™ Sequencing

Standard Application



R_{set} = Resistor to set the desired ooutput voltage (see spec. table for values).
C_{in} = Required electrolytic 1,000 µF
C_{out} = Recommended 330 µF electrolytic

TEXAS INSTRUMENTS

Ordering Information

Output Voltage (PTH03020❒xx)

Code	Voltage
W	0.8 V – 2.5 V (Adjust)

Package Options (PTH03020x❒❒) (1)

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

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 2.5 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.

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

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.

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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."*

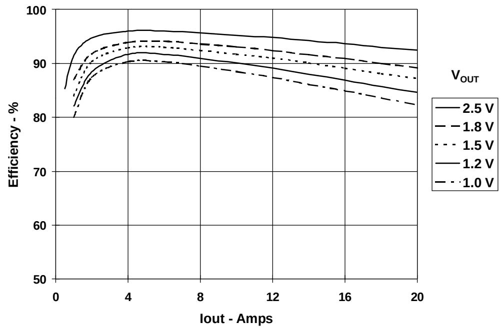
Specifications (Unless otherwise stated, T_a =25 °C, V_{in} =3.3 V, V_{out} =2.5 V, C_{in} =1,000 µF, C_{out} =0 µF, and I_o =$I_o$max)

			PTH03020W			
Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Output Current	I_o	60 °C, 200 LFM airflow 25 °C, natural convection	0 0	— —	22 (1) 22 (1)	A
Input Voltage Range	V_{in}	Over I_o range	2.95	—	3.65	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	—	±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 =10 A — 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	— — — — — —	95 95 93 91 90 88	— — — — — —	%
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth	—	20	—	mVpp
Over-Current Threshold	I_o trip	Reset, followed by auto-recovery	—	41	—	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	 — —	 TBD TBD	 — —	 µSec mV
Margin Up/Down Adjust	V_o adj		—	± 5	—	%
Margin Input Current (pins 9 /10)	I_{IL} margin	Pin to GND	—	– 8 (2)	—	µA
Track Input Current (pin 8)	I_{IL} track	Pin to GND	—	—	–130 (3)	µA
Track Slew Rate Capability	dV_{track}/dt	$\lvert V_{track} – V_o \rvert$ ≤ 50 mV and V_{track} < V_o(nom)	5	—	—	V/ms
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— 2.2	2.8 2.7	2.95 —	V
Inhibit Control (pin3) 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 3) to GND, Track (pin 8) open	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	250	300	340	kHz
External Input Capacitance	C_{in}		1,000 (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

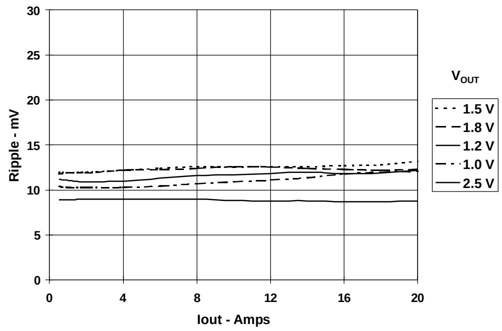
Notes: (1) *See SOA curves or consult factory for appropriate derating.*
(2) *A small low-leakage (<100 nA) MOSFET is recommended to control this pin. The open-circuit voltage is less than 1 Vdc.*
(3) *This control pin has an internal pull-up to the input voltage Vin. If it is left open-circuit the module 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 1,000 µF electrolytic input capacitor is required for proper operation. The capacitor must be rated for a minimum of 700 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} =3.3V *(See Note A)*

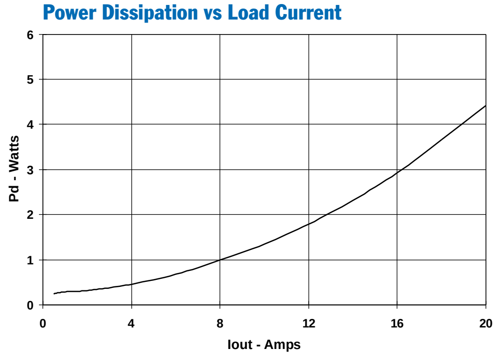
Efficiency vs Load Current



Output Ripple vs Load Current

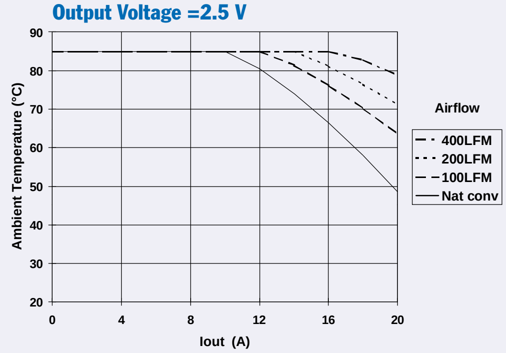


Power Dissipation vs Load Current



Safe Operating Area; V_{in} =3.3 V *(See Note B)*

Output Voltage =2.5 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 PTH03020 & PTH05020 Series of Power Modules

Input Capacitor

The recommended input capacitance is determined by 700 mArms minimum ripple current rating and 1,000 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 equal to or less than 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/594/595or 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

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

Capacitor Table

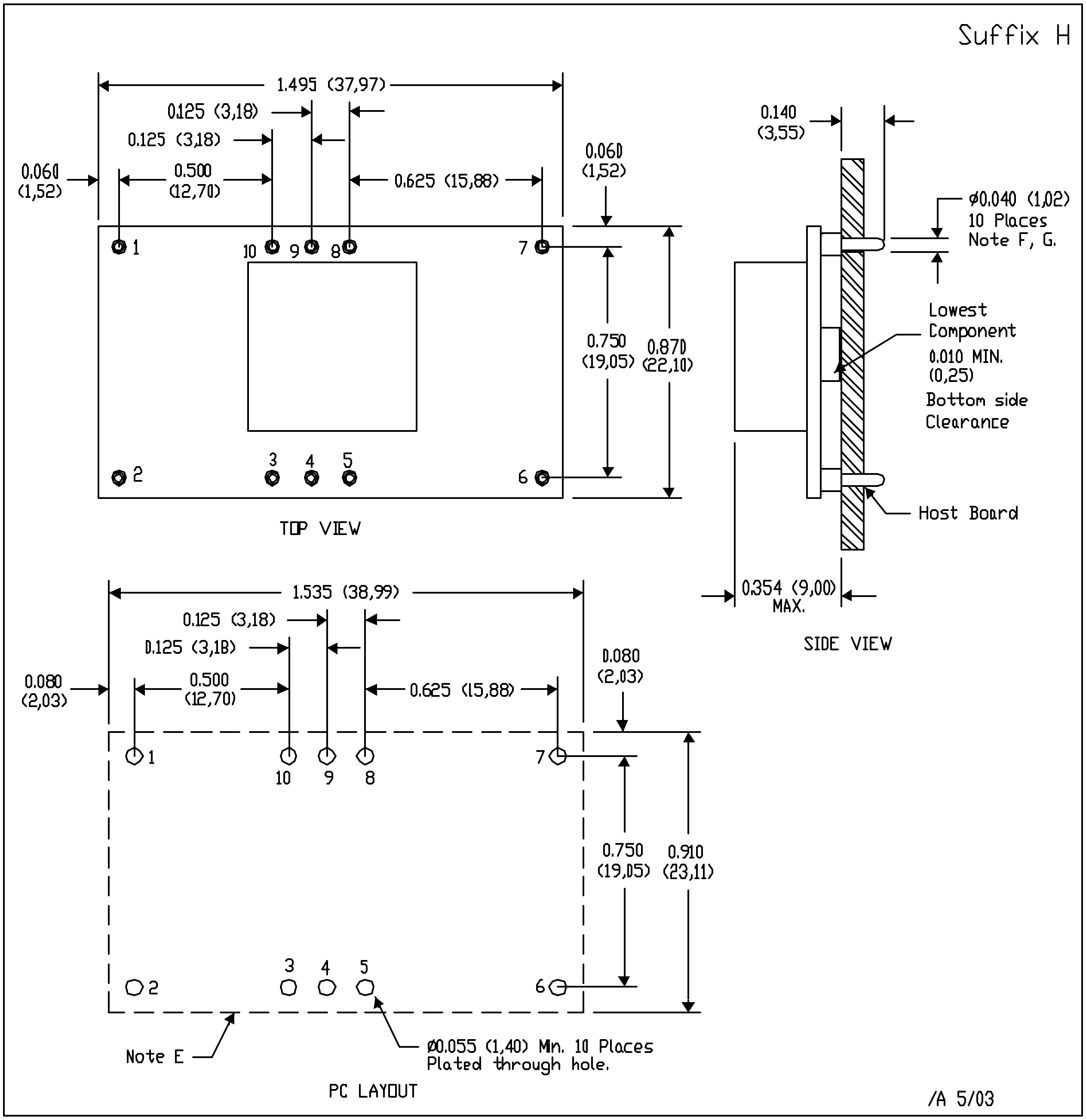
Table 2-1 identifies the characteristics of capacitors from a number of vendors with acceptable ESR and ripple current (rms) ratings. The number of capacitors required at both the input and output buses is identified for each capacitor type.

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 2-1: Input/Output Capacitors

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 Part Number
Panasonic FC (Radial) FK (Surface Mt.)	10 V 10 V 25 V 10 V	560 1000 1000 1000	0.090 Ω 0.068 Ω 0060 Ω 0.080 Ω	755 mA 1050 mA 1100 mA 850 mA	10×12.5 10×16 12.5×13.5 10×10.2	2 1 1 1	1 1 1 1	EEUFC1A561 EEUFC1A102 EEVFK1E102Q EEVFK1A102P
United Chemi-con LXZ Series FX PXA (Surface Mt.)	6.3 V 6.3 V 10 V 10 V	470 1000 680 1000	0.020 Ω 0.013 Ω 0.090 Ω 0.068 Ω	4130 mA 4935 mA 760 mA 1050 mA	10×7.7 10×10.5 10×12.5 10×16	2 1 2 1	1 1 1 1	PXA6.3VC471MJ80TP 6FX1000M LXZ10VB681M10X12LL LXZ10VB102M10X16LL
Nichicon PM Series NA NX (Surface Mt.)	6.3 V 10 V 10 V 16 V	470 470 1000 1000	0.020 Ω 0.018 Ω 0.065 Ω 0.055 Ω	4130 mA 4400 mA 1060mA 4400 mA	10×8 10×8 16×15 10×10	2 2 1 1	1 1 1 1	PNX0J471MCAR1GS PNA1A471M1 UPM1A102MPH6 UPM1C 102MHH6
Sanyo-Os-con: SP SVP (Surface Mt.)	10 V 10 V	470 560	0.015 Ω 0.013 Ω	>4500 mA >5200 mA	10×10.5 10×12.7	2 2	1 1	10SP470M 10SVP560M
AVX Tantalum TPS (Surface Mt.)	10 V 10 V	470 470	0.045 Ω 0.060 Ω	1723 mA 1826 mA	7.3L ×5.7W ×4.1H	2 2	1 1	TPSE477M010R0045 TPSV477M010R0060
Kemet Polymer Tantalum T520/T530 Series (Surface Mt.)	10 V 10 V	330 330	0.040 Ω 0.015 Ω	1800 mA >3800 mA	4.3W ×7.3L ×4.0H	3 3	1 1	T520X337M010AS T530X337M010AS
Sprague Tantalum 595D Series (Surface Mt.)	10 V	470	0.100Ω	1440 mA	7.2L ×6W ×4.1H	2	1	595D477X0010R2T

EUK (R-PDSS-T10) DOUBLE SIDED MODULE



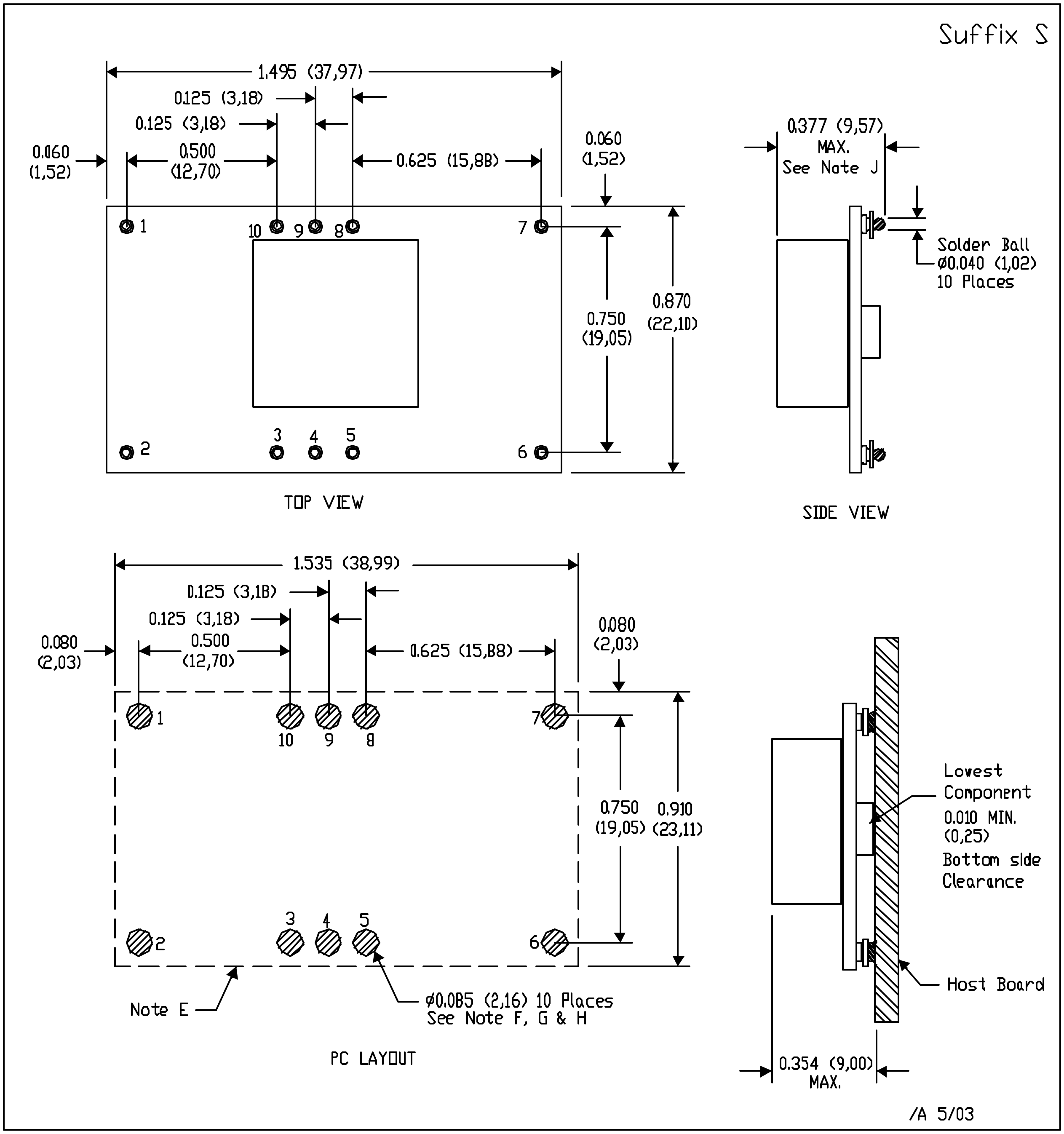
NOTES:

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.

E. Pins are 0.040" (1,02) diameter with 0.070" (1,78) diameter standoff shoulder.
F. All pins: Material – Copper Alloy
Finish – Tin (100%) over Nickel plate

SCALE	SIZE		REV	SHEET
2X				2/3

EUL (R-PDSS-B10) 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. Power pin connection should utilize four 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

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