6-A, 5-V Input Non-Isolated Wide-Output Adjust Power Module

SLTS201A – MAY 2003 – REVISED MAY 2003

NOMINAL SIZE = 0.75 in x 0.5 in (19,05 mm x 12,7 mm)

Features

- Up to 6-A Output Current
- 5-V Input Voltage
- Wide-Output Voltage Adjust (0.9 V to 3.6 V)
- Efficiencies up to 94 %
- 160 W/in³ Power Density
- On/Off Inhibit
- Under-Voltage Lockout
- Output Over-Current Protection (Non-Latching, Auto-Reset)
- Pre-Bias Startup
- Over-Temperature Protection
- Surface Mountable
- Operating Temp: –40 to +85 °C
- DSP Compatible Output Voltages
- IPC Lead Free 2

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Description

The PTH05000 series of non-isolated power modules are small in size and high on performance. Using double-sided surface mount construction and synchronous rectification technology, these regulators deliver up to 6 A of output current while occupying a PCB area of about half the size of a standard postage stamp. They are an ideal choice for applications where space, performance and cost are important design constraints.

The series operates from an input voltage of 5 V to provide step-down power conversion to any output voltage over the range, 0.9 V to 3.6 V. The output voltage of the PTH05000W is set within this range using a single resistor.

Operating features include an on/off inhibit, output voltage adjust (trim), output over-current protection, and over-temperature protection. For high efficiency these parts employ a synchronous rectifier output stage. An output pre-bias holdoff capability ensures that the output will not sink current during startup.

Target applications include telecom, industrial, and general purpose circuits, including low-power dual-voltage systems that use a DSP, microprocessor, or ASIC.

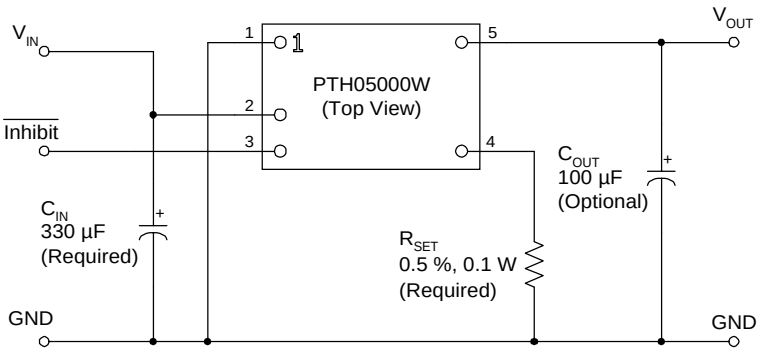
Package options include both through-hole and surface mount configurations.

Pin Configuration

Pin	Function
1	GND
2	V_{in}
3	Inhibit *
4	V_o Adjust
5	V_{out}

* *Denotes negative logic:*
Open = Output On
Ground = Output Off

Standard Application



R_{set} = Reistor to set the desired output voltage (see spec. table for values)
C_{in} = Required electrolytic 330 µF
C_{out} = Recommended 100 µF electrolytic

Ordering Information

Output Voltage (PTH05000❒xx)

Code	Voltage
W	0.9 V – 3.6 V (Adjust)

Package Options (PTH05000x❒❒) (1)

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

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

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

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 'Inhibit' and 'V_o Adjust' control input.

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

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 0.9 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.

$$R_{set} = 10\ k \cdot \frac{0.891\ V}{V_{out} - 0.9\ V} - 3.24\ k$$

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

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

Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Operating Temperature Range	T_a	Over V_{in} Range	–40 (i)	—	+85	°C
Solder Reflow Temperature	T_{reflow}	Surface temperature of module body or pins			215 (ii)	°C
Storage Temperature	T_s	—	–40	—	+125	°C
Over Temperature Protection	OTP	IC junction temperature	—	150	—	°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	—		—	2	—	grams
Flammability	—	Meets UL 94V-O				

Notes: *(i) For operation below 0 °C the external capacitors must have stable characteristics. Use either a low ESR tantalum or Oscon® capacitor.*
(ii) 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."

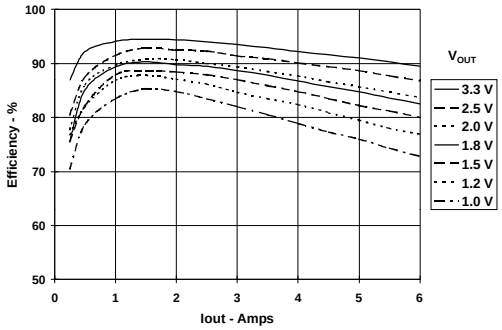
Electrical Specifications Unless otherwise stated, T_a =25 °C, V_{in} =5 V, V_{out} =3.3 V, C_{in} =330 µF, C_{out} =0 µF, and I_o =I_o(max)

Characteristics	Symbols	Conditions	PTH05000W Min	PTH05000W Typ	PTH05000W Max	Units
Output Current	I_o	T_a =25 °C, natural convection T_a =60 °C, 200LFM	0 0	— —	6 (1) 5.25 (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	—	±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	V_{in} =5 V, I_o =4 A R_{SET} = 475 Ω V_o=3.3 V	—	92	—	%
		R_{SET} = 2.32 kΩ V_o=2.5 V	—	90	—	
		R_{SET} = 4.87 kΩ V_o=2.0 V	—	88	—	
		R_{SET} = 6.65 kΩ V_o=1.8 V	—	87	—	
		R_{SET} = 11.5 kΩ V_o=1.5 V	—	84	—	
		R_{SET} = 26.1 kΩ V_o=1.2 V	—	82	—	
		R_{SET} = 84.5 kΩ V_o=1.0 V	—	79	—	
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth V_o≥3.3 V V_o≤2.5 V	— —	30 25	— —	mVpp
Transient Response		1 A/µs load step, 50 to 100 % $I_o$max, V_o =1.8 V, C_{out} =100 µF				
	t_{tr}	Recovery time	—	70	—	µSec
	ΔV_{tr}	V_o over/undershoot	—	100	—	mV
Current Limit Threshold	I_{lim}	ΔV_o = –50 mV	—	13	—	A
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— 3.4	3.8 3.5	3.85 —	V
Inhibit Control (pin 3)		Referenced to GND				
Input High Voltage	V_{IH}		V_{in} –0.5	—	Open (2)	V
Input Low Voltage	V_{IL}		–0.2	—	0.8	
Input Low Current	I_{IL}	Pin 3 to GND	—	–10	—	µA
Standby Input Current	I_{in} standby	pins 1 & 3 connected	—	1	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	—	700	—	kHz
External Input Capacitance	C_{in}		330 (3)	—	—	µF
External Output Capacitance	C_{out}		0	100 (4)	TBD	µF
Reliability	MTBF	Per Bellcore TR-332 50 % stress, T_a =40 °C, ground benign	TBD	—	—	10^6 Hrs

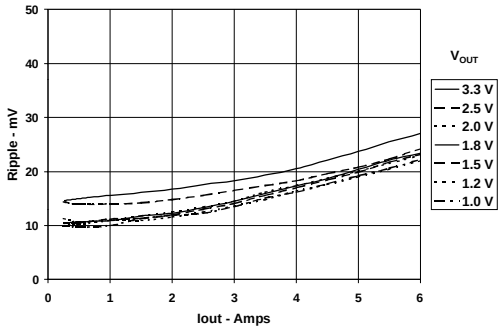
Notes: *(1) See SOA curves or consult factory for appropriate derating.*
(2) The Inhibit control (pin 3) has an internal pull-up to Vin, and if left open-circuit the module will operate when input power is applied. A small low-leakage (<100 nA) MOSFET is recommended to control this input. See application notes for more information.
(3) The regulator requires a minimum of 330 µF input capacitor with a minimum 300 mArms ripple current rating. For further information, consult the related application note on Capacitor Recommendations.
(4) An external output capacitor is not required for basic operation. Adding 100 µF of distributed capacitance at the load will improve the transient response.

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

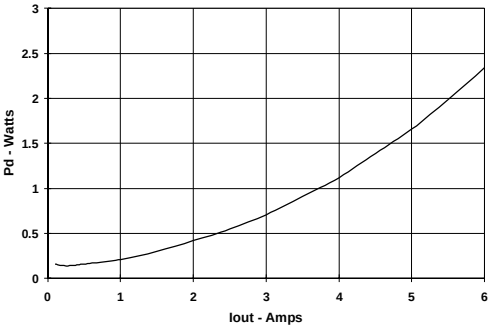
Efficiency vs Output Current



Ripple vs Output Current

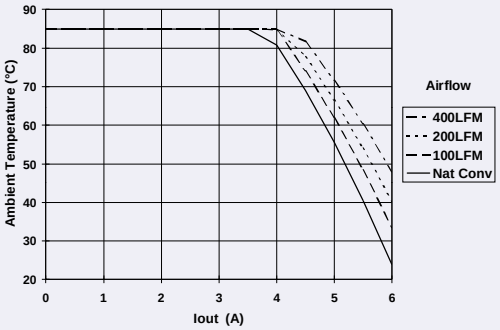


Power Dissipation vs Output Current



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

Output Voltage =3.3 V



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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 PTH05000 Series of 6-A Power Modules

Input Capacitors

The recommended input capacitance is determined by 300 mA (rms) minimum ripple current rating, less than 300 mΩ equivalent series resistance (ESR) and 330 µF minimum capacitance. The ripple current rating, ESR, and operating temperature are the major considerations when selecting the input capacitor.

It is recommended that tantalum capacitors have a minimum voltage rating of at least twice the working voltage, including the ac ripple. This is necessary to insure reliability with 3.3-V input voltage bus applications.

Output Capacitors (optional)

The ESR of the required capacitor can be less than, or equal to 200 mΩ. Electrolytic capacitors have poor ripple performance at frequencies greater than 400 kHz but excellent low frequency transient response. Above the ripple frequency, ceramic decoupling capacitors are recommended to improve the transient response and reduce any high frequency noise components apparent during higher current excursions. Preferred low ESR type capacitor's part numbers are identified in the capacitor table.

Tantalum/ Ceramic Capacitors

Tantalum capacitors are acceptable on the output bus. Either tantalum or Os-con® capacitor types are recommended for applications where ambient temperatures fall below 0 °C. Electrolytic capacitors may be substituted with ceramic types with the minimum capacitance on the input bus.

Capacitor Table

Table 1-1 identifies capacitors with acceptable ESR and maximum allowable ripple current (rms) ratings. Capacitors recommended for the output are identified under the Output Bus column with the required quantity.

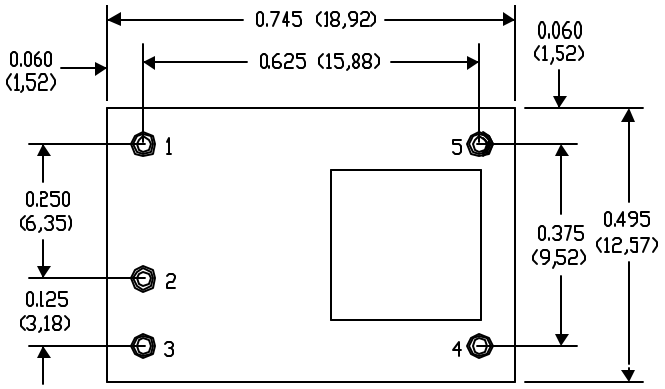
This is not an extensive capacitor list. Capacitors from other vendors are available with comparable specifications. Those listed are for guidance. The RMS ripple current rating and ESR (at 100 kHz) are critical parameters necessary to insure both optimum regulator performance and long capacitor life.

Table 1-1; Recommended Input/Output Capacitors

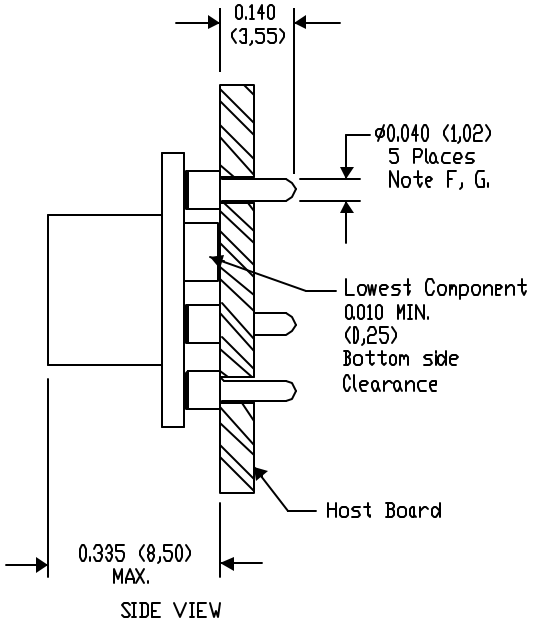
Capacitor Vendor/ Component Series	Capacitor Characteristics					Quantity		
	Working Voltage	Value (µF)	(ESR) Equivalent Series Resistance	85°C Maximum Ripple Current (Irms)	Physical Size (mm)	Input Bus	Output Bus	Vendor Number
Panasonic FC (SMT)	10 V 16 V	330 µF 330 µF	0.117 Ω 0.150 Ω	555 mA 670mA	8×11.5 10×10.2	1 1	1 1	EEUFC1A331 EEVFC1C331P
United Chemi–con LXZ PXA (SMT) MVZ (SMT) FS	 10 V 10 V 16 V 25 V	 330 µF 330 µF 330 µF 330 µF	 0.025 Ω 0.024 Ω 0.120 Ω 0.170 Ω	 3500 mA 3770 mA 555 mA 450 mA	 10×10.5 10×7.7 8×12 8×10	 1 1 1 1	 1 1 1 1	 10FS330M PXA10VC331MJ80TP LXZ16VB331M8x12LL MVZ25VC331MH10TP
Nichicon NX (SMT) NA PM	 10 V 10 V 10 V	 330 µF 470 µF 330 µF	 0.024 Ω 0.018 Ω 0.160 Ω	 >2800 mA >3100 mA 460 mA	 10×8 10×10 8×11.5	 1 1 1	 1 1 1	 PNX1A331MCR1GS PNA1A471M1 UPM1A331MHH
Panasonic FK (SMT)	16 V 25 V	330 µF 330 µF	0.160 Ω 0.160 Ω	600 mA 600 mA	8×10.2 8×10.2	1 1	1 1	EEVFK1C331P EEVFK1E331P
Sanyo Os-con® SVP (SMT) SP	 10 V 10 V	 330 µF 470 µF	 0.025 Ω 0.015 Ω	 >3700 mA >4500 mA	 10×8 10×10.5	 1 1	 1 1	 10SVP330MX 10SP470M
AVX Tantalum TPS	10 V 10 V	330 µF 330 µF	0.100 Ω 0.060 Ω	>1100 mA >2000 mA	7.3L ×4.3W ×4.1H	1 1	1 1	TPSV337M010R0100 TPSV337M010R0060
Kemet T520 T495	10 V 10 V	330 µF 330 µF	0.035 Ω 0.040 Ω	> 1200 mA >1100 mA	7.3L ×5.7W ×4.0H	1 1	1 1	T510X337M010AS T520X337M010AS
Sprague 594D/595D	10 V 10 V	330 µF 330 µF	0.045 Ω 0.140 Ω	>1400 mA >1000 mA	7.3L ×6.0W ×4.1H	1 1	1 1	594D337X0010R2T 595D337X0010D2T

EUS (R-PDSS-T5) DOUBLE SIDED MODULE

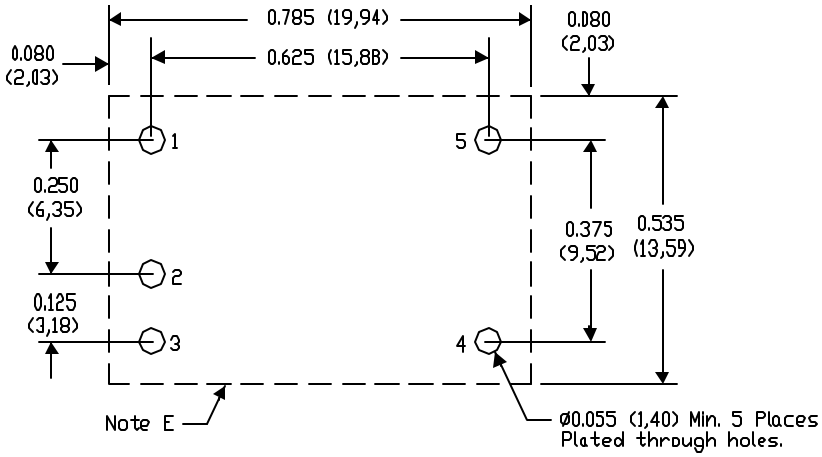
Suffix H



TOP VIEW



SIDE VIEW



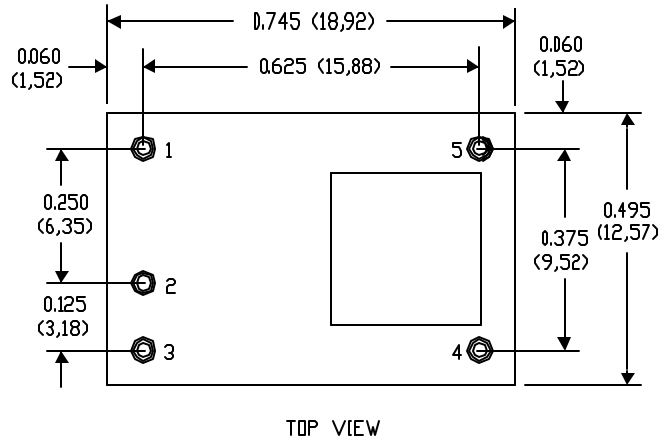
PC LAYOUT

/A 3/03

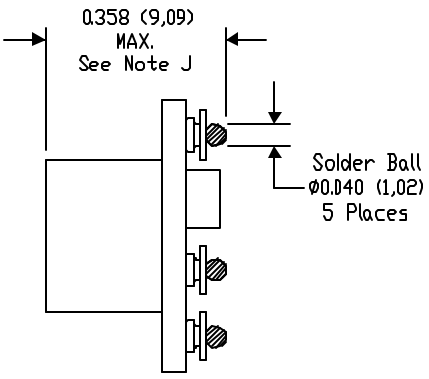
NOTES:
A. All linear dimensions are in inches (mm).
B. This drawing is subject to change without notice.
C. 2 place decimals are ±0.030 (±0,76mm).
D. 3 place decimals are ±0.010 (±0,25mm).
E. Recommended keep out area for user components.
F. Pins are 0.040" (1,02) diameter with 0.070" (1,78) diameter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

EUT (R-PDSS-B5) DOUBLE SIDED MODULE

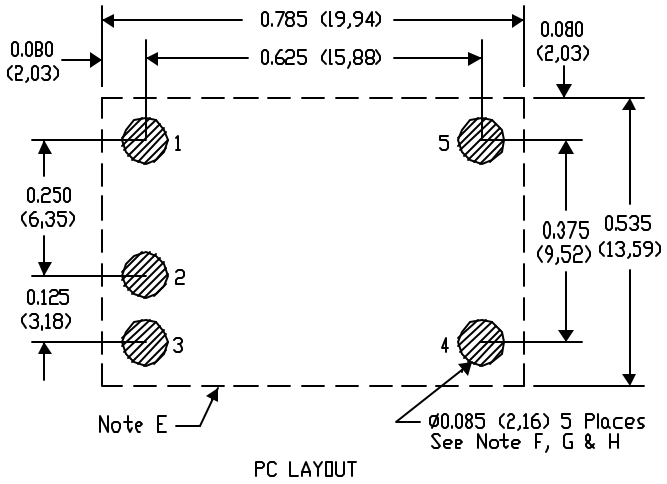
Suffix S



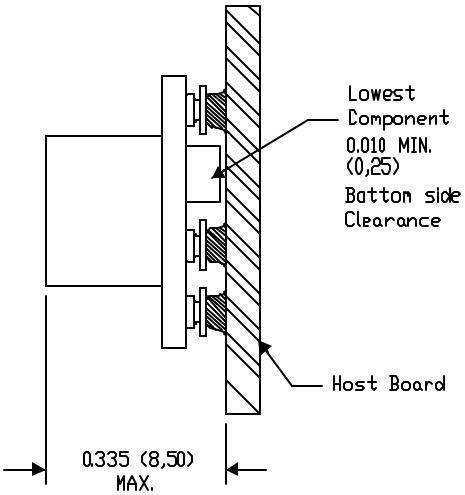
TOP VIEW



SIDE VIEW



PC LAYOUT



/A 3/03

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
3X				2/3

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