15-A, 4.75-V to 14-V INPUT, NON-ISOLATED, WIDE-OUTPUT, DIGITAL POWERTRAIN™ MODULE

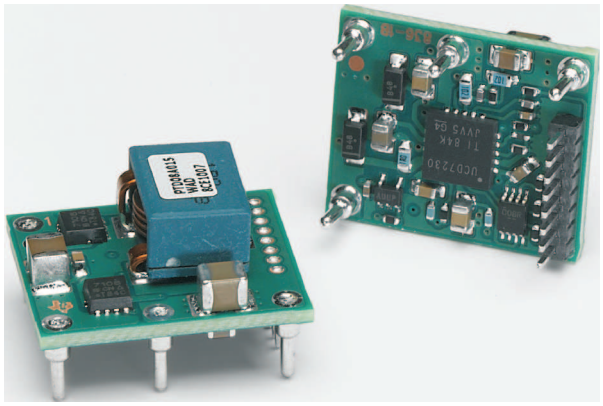
Check for Samples: PTD08A015W

FEATURES

- **Up to 15-A Output Current**
- **4.75-V to 14-V Input Voltage**
- **Programmable Wide-Output Voltage (0.7 V to 3.6 V)**
- **Efficiencies up to 96%**
- **Digital I/O**
  - **PWM signal**
  - **INHIBIT**
  - **Current limit flag (FAULT)**
  - **Sychronous Rectifier Enable (SRE)**
- **Analog I/O**
  - **Temperature**
  - **Output currrent**
- **Safety Agency Approvals: (Pending)**
  - **UL/IEC/CSA-C22.2 60950-1**
- **Operating Temperature: –40°C to 85°C**

APPLICATIONS

- **Digital Power Systems using UCD9XXX Digital Controllers**



DESCRIPTION

The PTD08A015W is a high-performance 15-A rated, non-isolated digital PowerTrain module. This module is the power conversion section of a digital power system which incorporates TI's UCD7230 MOSFET driver IC. The PTD08A015W must be used in conjunction with a digital power controller such as the UCD9240 or UCD9110 family. The PTD08A015W receives control signals from the digital controller and provides parametric and status information back to the digital controller. Together, PowerTrain modules and a digital power controller form a sophisticated, robust, and easily configured power management solution.

Operating from an input voltage range of 4.75 V to 14 V, the PTD08A015W provides step-down power conversion to a wide range of output voltages from 0.7 V to 3.6 V. The wide input voltage range makes the PTD08A015W particularly suitable for advanced computing and server applications that utilize a loosely regulated 8-V, 9.6-V or 12-V intermediate distribution bus. Additionally, the wide input voltage range increases design flexibility by supporting operation with tightly regulated 5-V or 12-V intermediate bus architectures.

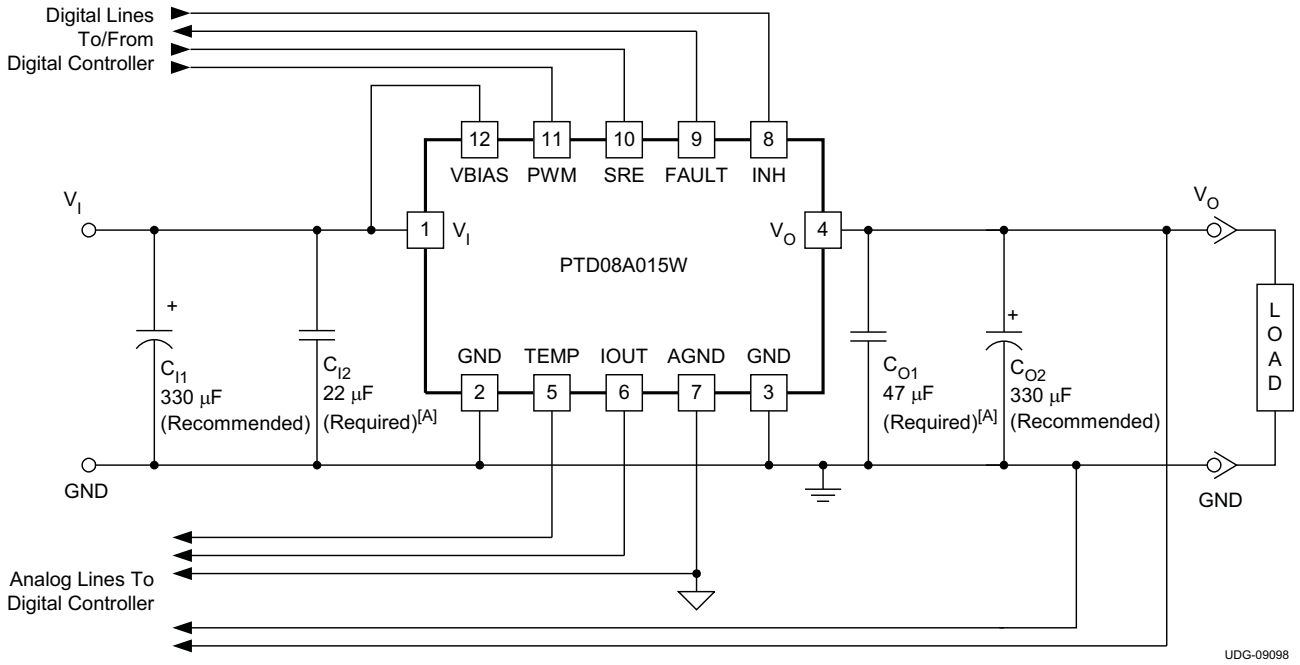
The module incorporates output over-current and temperature monitoring which protects against most load faults. Output current and module temperature signals are provided for the digital controller to permit user defined over-current and over-temperature warning and fault scerarios.

The module uses double-sided surface mount construction to provide a low profile and compact footprint. The PTD08A015W is constructed using through-hole pins and is lead (Pb) - free and RoHS compatible.

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

Standard PTD08A015W Application



A. [A] C_{I2} and C_{O1} are optional when the operating frequency is greater than 500 kHz.

ORDERING INFORMATION

For the most current package and ordering information, see the Package Option Addendum at the end of this datasheet, or see the TI website at www.ti.com.

DATASHEET TABLE OF CONTENTS

ENVIRONMENTAL AND ABSOLUTE MAXIMUM RATINGS

(Voltages are with respect to GND)

				UNIT
V_I	Input voltage		16	V
V_B	Bias voltage		16	V
T_A	Operating temperature range	Over V_I range	–40 to 85	°C
T_{wave}	Wave soldering temperature	Surface temperature of module body or pins for 5 seconds maximum	260	
T_{stg}	Storage temperature		–55 to 125 (1)	
	Mechanical shock	Per Mil-STD-883D, Method 2002.3, 1 msec, 1/2 sine, mounted	200	G
	Mechanical vibration	Mil-STD-883D, Method 2007.2, 20-2000 Hz	15	
	Weight		3.9	grams
MTBF	Reliability	Per Telcordia SR-332, 50% stress, T_A = 40°C, ground benign	9.4	10^6 Hr
	Flammability	Meets UL94V-O		

(1) The shipping tray or tape and reel cannot be used to bake parts at temperatures higher than 65°C.

ELECTRICAL CHARACTERISTICS

PTD08A015W

T_A= 25°C, F_{SW}= 350kHz, V_I= 12 V, V_O= 3.3 V, V_B= V_I, C_{I1}= 330 µF, C_{I2}= 22 µF ceramic, C_{O1}= 47 µF ceramic, C_{O2}= 330 µF, and I_O= $I_{O(max)}$ (unless otherwise stated)

PARAMETER		TEST CONDITIONS		PTD08A015W			UNIT
				MIN	TYP	MAX	
I_O	Output current	Over V_O range	25°C, natural convection	0		15	A
V_I	Input voltage range	Over I_O range		4.75		14 (1)	V
V_{OADJ}	Output voltage adjust range	Over I_O range		0.7 (1)		3.6	V
η	Efficiency	V_I = V_B = 5 V, I_O = 15 A, *f*s = 350 kHz	V_O = 3.3 V		94%		
			V_O = 2.5 V		92%		
			V_O = 1.8 V		89%		
			V_O = 1.5 V		87%		
			V_O = 1.2 V		85%		
			V_O = 1.0 V		82%		
V_{OPP}	V_O Ripple (peak-to-peak)	20-MHz bandwidth			20		mV_{PP}
V_B	Bias voltage			4.75		14	V
V_B UVLO	Bias voltage under voltage lockout		V_B increasing	4.25	4.5	4.75	V
			V_B decreasing	4.0	4.25	4.5	
I_B	Bias current	Inhibit (pin 8) to AGND	Standby		4		mA
			Switching		34		
V_{IH}	High-level input voltage	SRE, INH, & PWM input levels		2.0		5.5	V
V_{IL}	Low-level input voltage					0.8	
	PWM input	Frequency range		300		1000	kHz
		Pulse width limits		130			ns
	TEMP output	Range		-40		125	°C
		Accuracy, -40°C ≤ T_A ≤ 85°C		-4		6	°C
		Slope			10		mV/°C
		Offset, T_A = 0°C			500		mV
V_{OH}	FAULT output	High-level output voltage, I_{FAULT} = 4mA		2.7	3.3		V
V_{OL}		Low-level output voltage, I_{FAULT} = 4mA			0	0.6	
I_{LIM}		Overcurrent threshold; Reset, followed by auto-recovery			25		A
	IOUT output	Range		0.15		3.5	V
		Gain		60	85	110	mV/A
		Offset, I_O = 0A, V_O = 1.2V		0.44	0.6	0.76	V
		Output Impedance		10	15	21	kΩ
C_I	External input capacitance		Nonceramic		330 (2)		µF
			Ceramic	22 (2)			
C_O	External output capacitance	Capacitance Value	Nonceramic		330 (3)	5000 (4)	µF
			Ceramic	47 (3)		(3)	
		Equivalent series resistance (non-ceramic)		1 (5)			mΩ

(1) The maximum input voltage is duty cycle limited to (V_O/(130ns × F_{SW})) or 14 V, whichever is less. The maximum allowable input voltage is a function of switching frequency.

(2) A 22 µF ceramic input capacitor is required for proper operation. An additional 330 µF bulk capacitor rated for a minimum of 500mA rms of ripple current is recommended. When operating at frequencies > 500kHz the 22 µF ceramic capacitor is only recommended. Refer to the UCD9240 controller datasheet and user interface for application specific capacitor specifications.

(3) A 47 µF ceramic output capacitor is required for basic operation. An additional 330 µF bulk capacitor is recommended for improved transient response. When operating at frequencies > 500kHz the 47 µF ceramic capacitor is only recommended. Refer to the UCD9240 controller datasheet and user interface for application specific capacitor specifications.

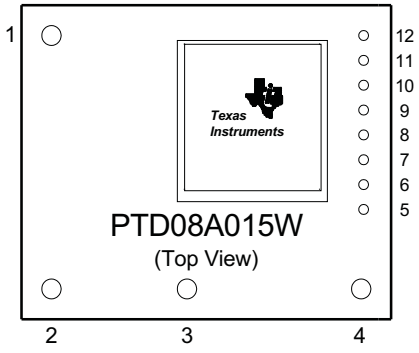
(4) 5,000 µF is the calculated maximum output capacitance given a 1V/msec output voltage rise time. Additional capacitance or increasing the output voltage rise rate may trigger the overcurrent threshold at start-up. Refer to the UCD9240 controller datasheet and user interface for application specific capacitor specifications.

(5) This is the minimum ESR for all non-ceramic output capacitance. Refer to the UCD9240 controller datasheet and user interface for application specific capacitor specifications.

TERMINAL FUNCTIONS

TERMINAL		DESCRIPTION
NAME	NO.	
V_I	1	The positive input voltage power node to the module, which is referenced to common GND.
GND	2	This is the common ground connection for the V_I and V_O power connections.
	3	
V_O	4	The regulated positive power output with respect to GND.
TEMP	5	Temperature sense output. The voltage level on this pin represents the temperature of the module.
IOUT	6	Current sense output. The voltage level on this pin represents the average output current of the module.
AGND	7	Analog ground return. It is the 0 V_{dc} reference for the control inputs.
INH(1)	8	The inhibit pin is a negative logic input that is referenced to AGND. Applying a low-level signal to this pin disables the module and turns off the output voltage. A 10 kΩ pull-up to 3.3 V or 5 V is required if the INH signal is not used.
FAULT	9	Current limit flag. The Fault signal is a 3.3 V digital output which is latched high after an over-current condition. The Fault is reset after two complete PWM cycles without an over-current condition (third rising edge of the PWM).
SRE	10	Synchronous Rectifier Enable. This pin is a high impedance digital input. A 3.3 V or 5 V logic level signals is used to enable the synchronous rectifier switch. When this signal is high, the module will source and sink output current. When this signal is low, the module will only source current.
PWM	11	This is the PWM input pin. It is a high impedance digital input that accepts 3.3 V or 5 V logic level signals up to 1 MHz.
VBIAS	12	Bias voltage supply required to power internal circuitry. For optimal performance connect VBIAS to V_I.

(1) Denotes negative logic: High = Normal operation, Low = Function active



TYPICAL CHARACTERISTICS (V_I = 12 V) (1)

EFFICIENCY vs LOAD CURRENT

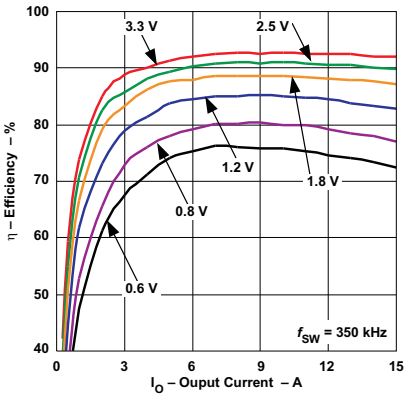


Figure 1.

EFFICIENCY vs LOAD CURRENT

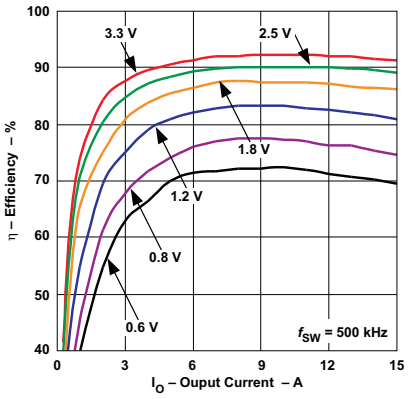


Figure 2.

EFFICIENCY vs LOAD CURRENT

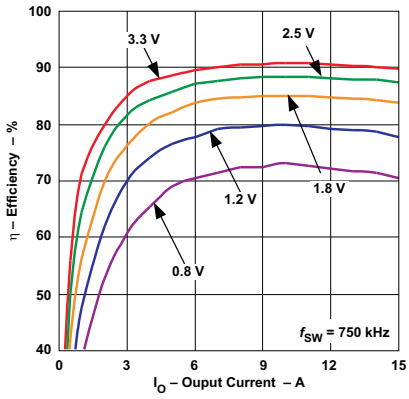


Figure 3.

EFFICIENCY vs LOAD CURRENT

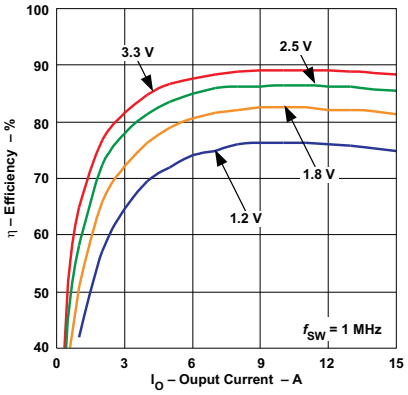


Figure 4.

POWER DISSIPATION vs LOAD CURRENT

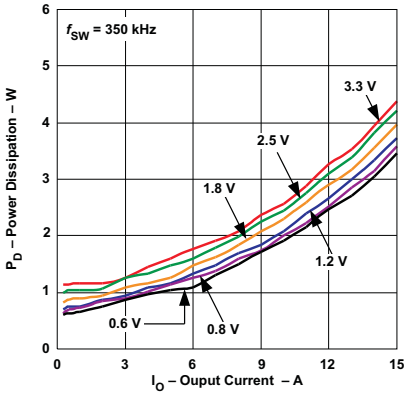


Figure 5.

POWER DISSIPATION vs LOAD CURRENT

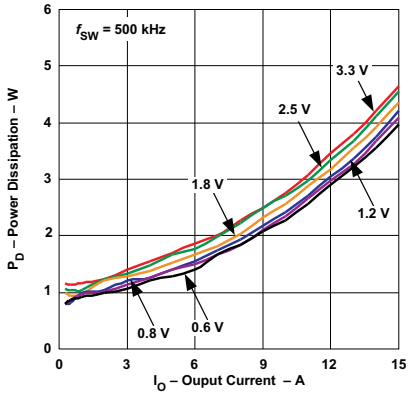


Figure 6.

POWER DISSIPATION vs LOAD CURRENT

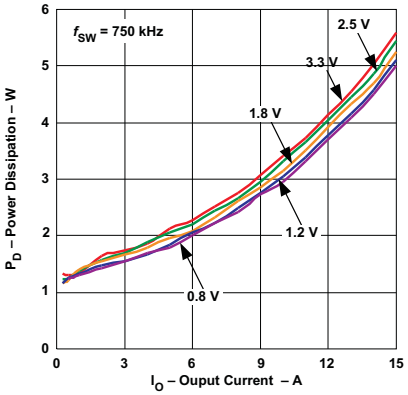


Figure 7.

POWER DISSIPATION vs LOAD CURRENT

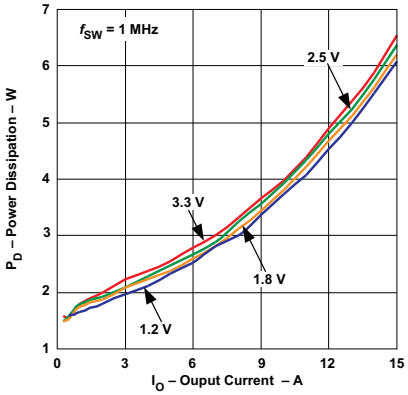


Figure 8.

INPUT BIAS CURRENT vs SWITCHING FREQUENCY

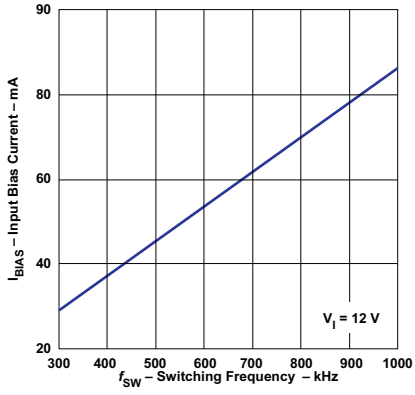


Figure 9.

(1) The electrical characteristic data has been developed from actual products tested at 25°C. This data is considered typical for the converter.

TYPICAL CHARACTERISTICS (V_I = 12 V)

Safe Operating Area (1)

AMBIENT TEMPERATURE vs LOAD CURRENT

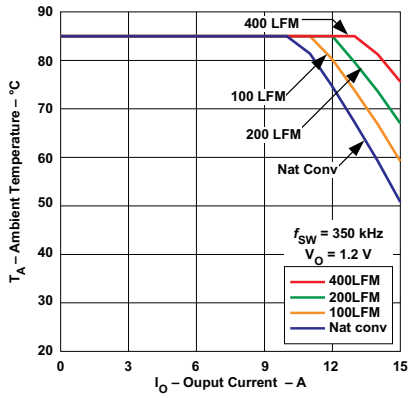


Figure 10.

AMBIENT TEMPERATURE vs LOAD CURRENT

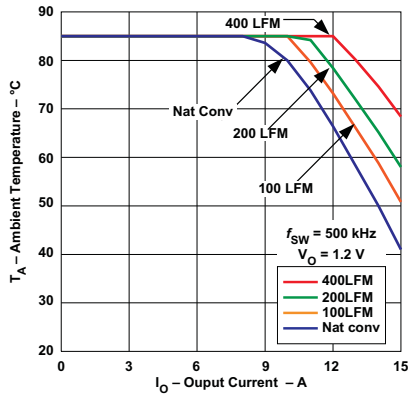


Figure 11.

AMBIENT TEMPERATURE vs LOAD CURRENT

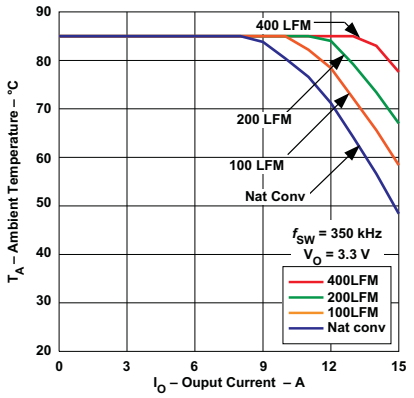


Figure 12.

AMBIENT TEMPERATURE vs LOAD CURRENT

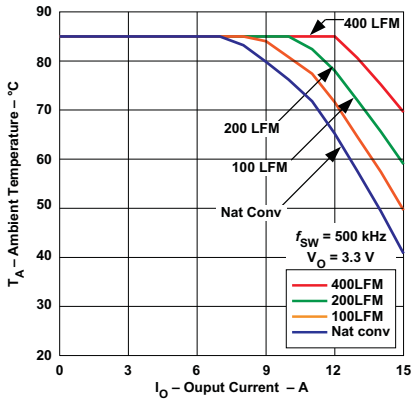


Figure 13.

(1) The temperature derating 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 100 mm x 100 mm double-sided PCB with 2 oz. copper. Please refer to the mechanical specification for more information.

TYPICAL CHARACTERISTICS (V_I = 5 V) (1)

EFFICIENCY vs LOAD CURRENT

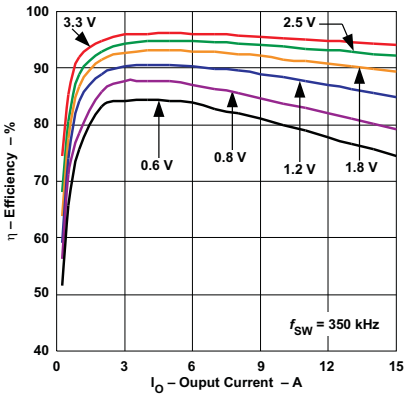


Figure 14.

EFFICIENCY vs LOAD CURRENT

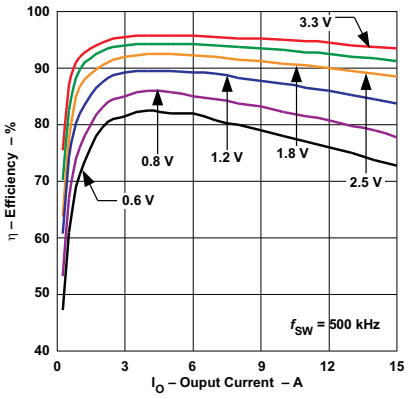


Figure 15.

EFFICIENCY vs LOAD CURRENT

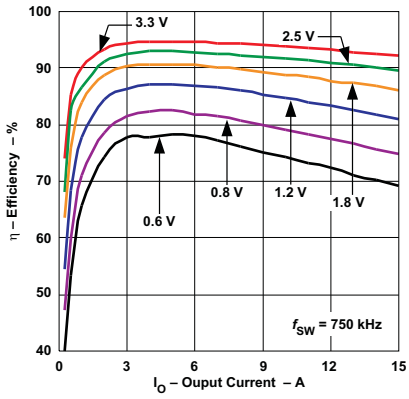


Figure 16.

EFFICIENCY vs LOAD CURRENT

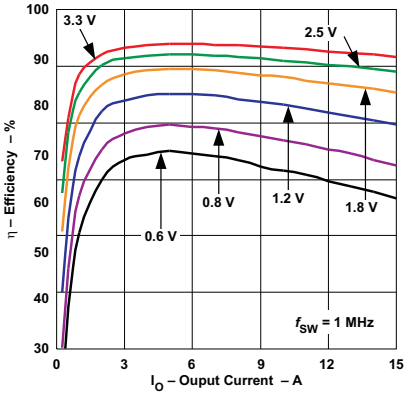


Figure 17.

POWER DISSIPATION vs LOAD CURRENT

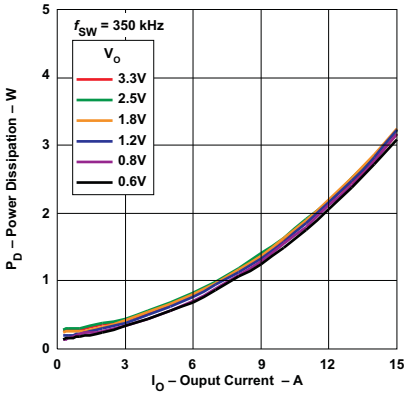


Figure 18.

POWER DISSIPATION vs LOAD CURRENT

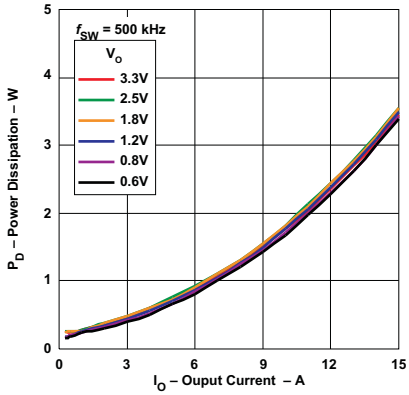


Figure 19.

POWER DISSIPATION vs LOAD CURRENT

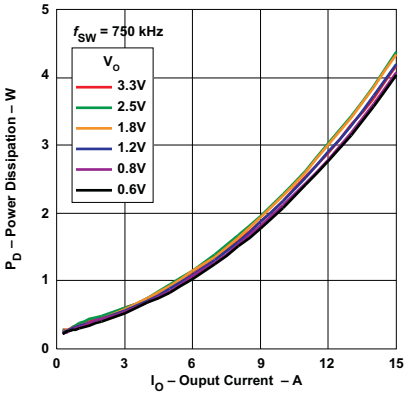


Figure 20.

POWER DISSIPATION vs LOAD CURRENT

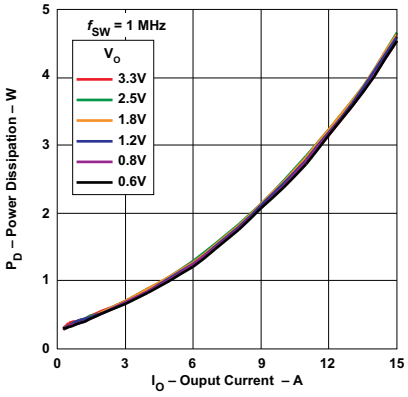


Figure 21.

INPUT BIAS CURRENT vs SWITCHING FREQUENCY

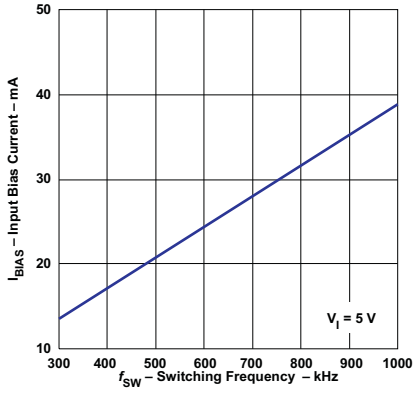


Figure 22.

(1) The electrical characteristic data has been developed from actual products tested at 25°C. This data is considered typical for the converter.

TYPICAL CHARACTERISTICS (V_I = 5 V)

Safe Operating Area (1)

AMBIENT TEMPERATURE vs LOAD CURRENT

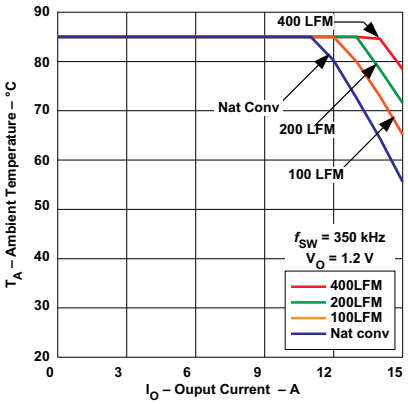


Figure 23.

AMBIENT TEMPERATURE vs LOAD CURRENT

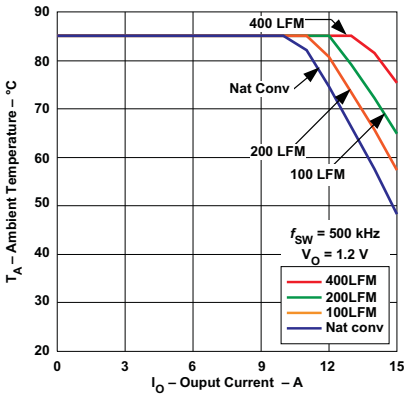


Figure 24.

AMBIENT TEMPERATURE vs LOAD CURRENT

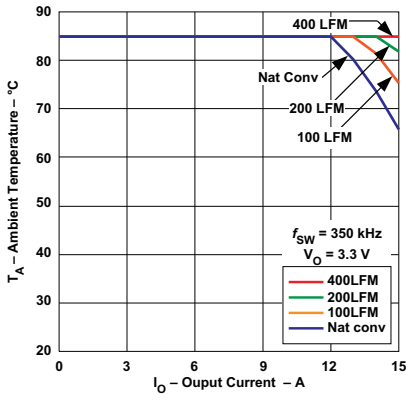


Figure 25.

AMBIENT TEMPERATURE vs LOAD CURRENT

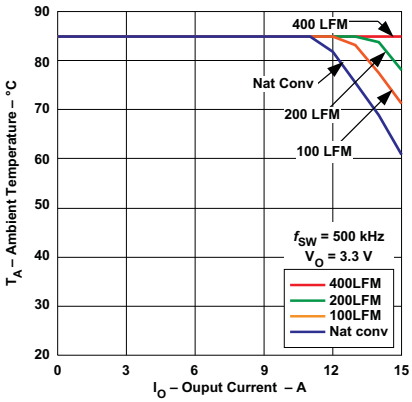


Figure 26.

(1) The temperature derating 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 100 mm x 100 mm double-sided PCB with 2 oz. copper. Please refer to the mechanical specification for more information.

APPLICATION INFORMATION

DIgital Power

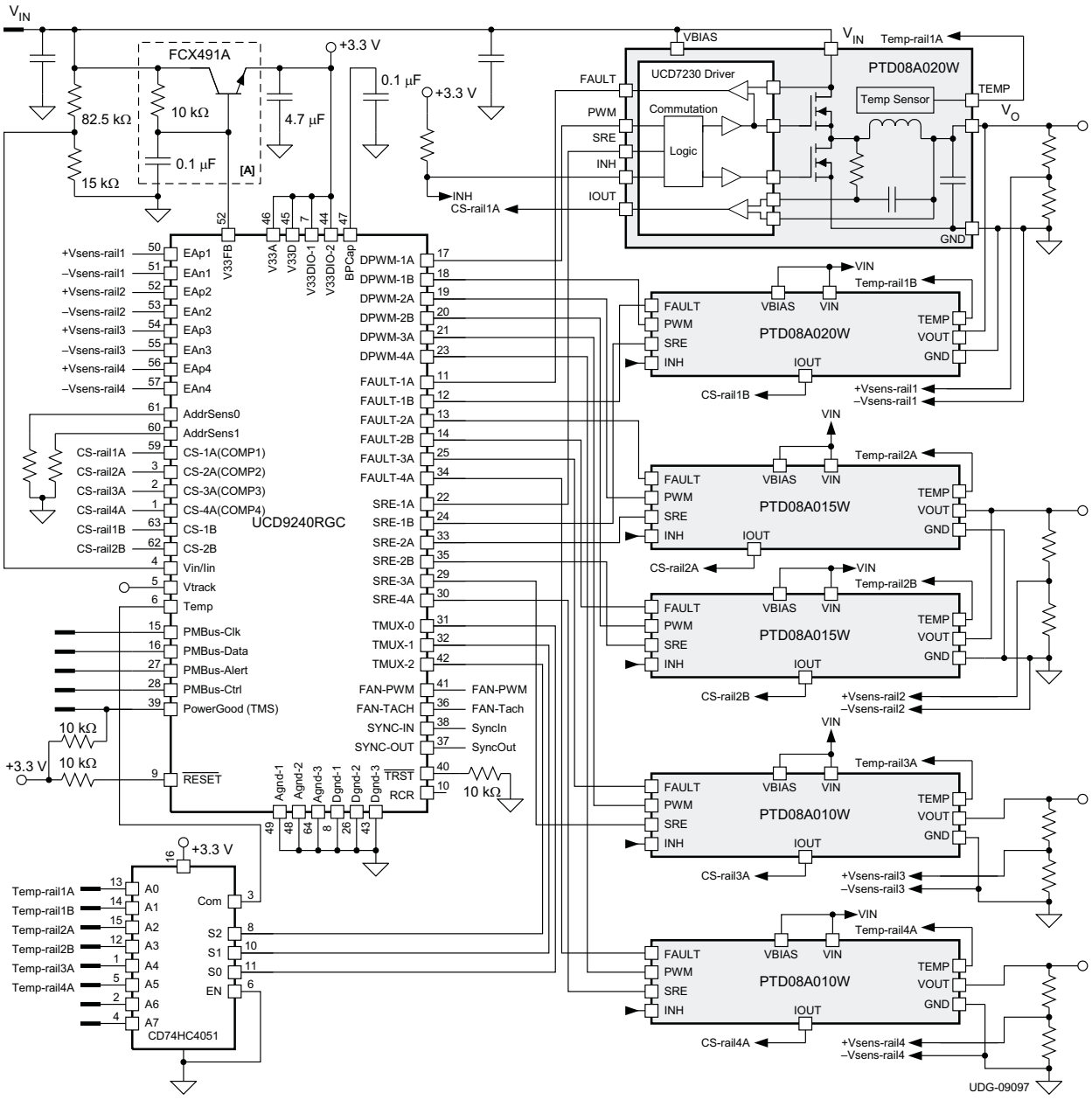


Figure 27. Typical Application Schematic

A. This discrete bias power circuit may be substituted with a low dropout regulator (LDO). For example, TPS715A33 can provide bias power to the UCD9240.

Figure 27 shows the UCD9240 power supply controller working in a system which requires the regulation of four independent power supplies. The loop for each power supply is created by the respective voltage outputs feeding into the Error ADC differential inputs, and completed by DPWM outputs feeding into the UCD7230 drivers which are shown on the PTD08A0x0W modules.

UCD9240 Graphical User Interface (GUI)

When using the UCD9240 digital controller along with digital PowerTrain modules to design a digital power system, several internal parameters of the modules are required to run the Fusion Digital Power Designer GUI. See the plant parameters below for the PTD08A015W digital PowerTrain modules.

Table 1. PTD08A015W Plant Parameters

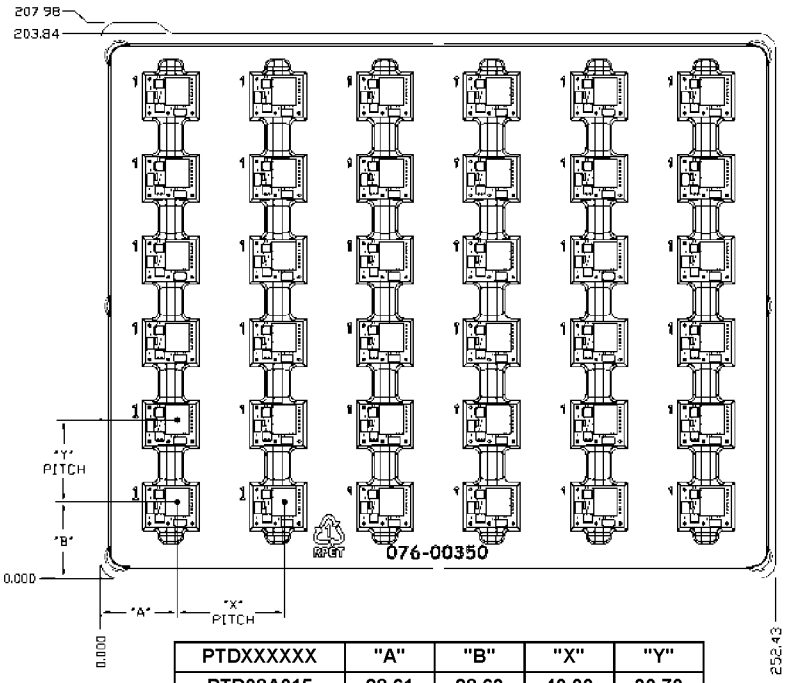
PTD08A015W Plant Parameters			
L (µH)	**DCR (mΩ)**	**Rds-on-hi (mΩ)**	**Rds-on-lo (mΩ)**
0.90	2.2	3.6	3.6

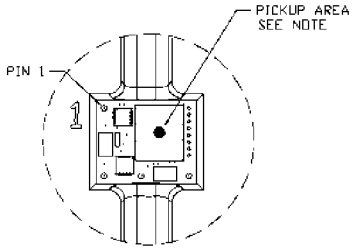
Internal output capacitance is present on the digital PowerTrain modules themselves. When using the GUI interface this capacitance information must be included along with any additional external capacitance. See the capacitor parameters below for the PTD08A015W digital PowerTrain modules.

Table 2. PTD08A015W Capacitor Parameters

PTD08A015W Capacitor Parameters			
C (µF)	**ESR (mΩ)**	**ESL (nH)**	**Quantity**
47	1.5	2.5	1

TRAY





NOTE: THE INDUCTOR IS USED TO PICK AND PLACE THE MODULE. IT'S LOCATION MAY VARY FROM PACKAGE STYLE. SEE PRODUCT TABLE

DEVICES/TRAY	36

PTDXXXXXX	"A"	"B"	"X"	"Y"
PTD08A015	28.61	28.63	40.00	30.70
All dimensions are in millimeters.				

PACKAGING INFORMATION

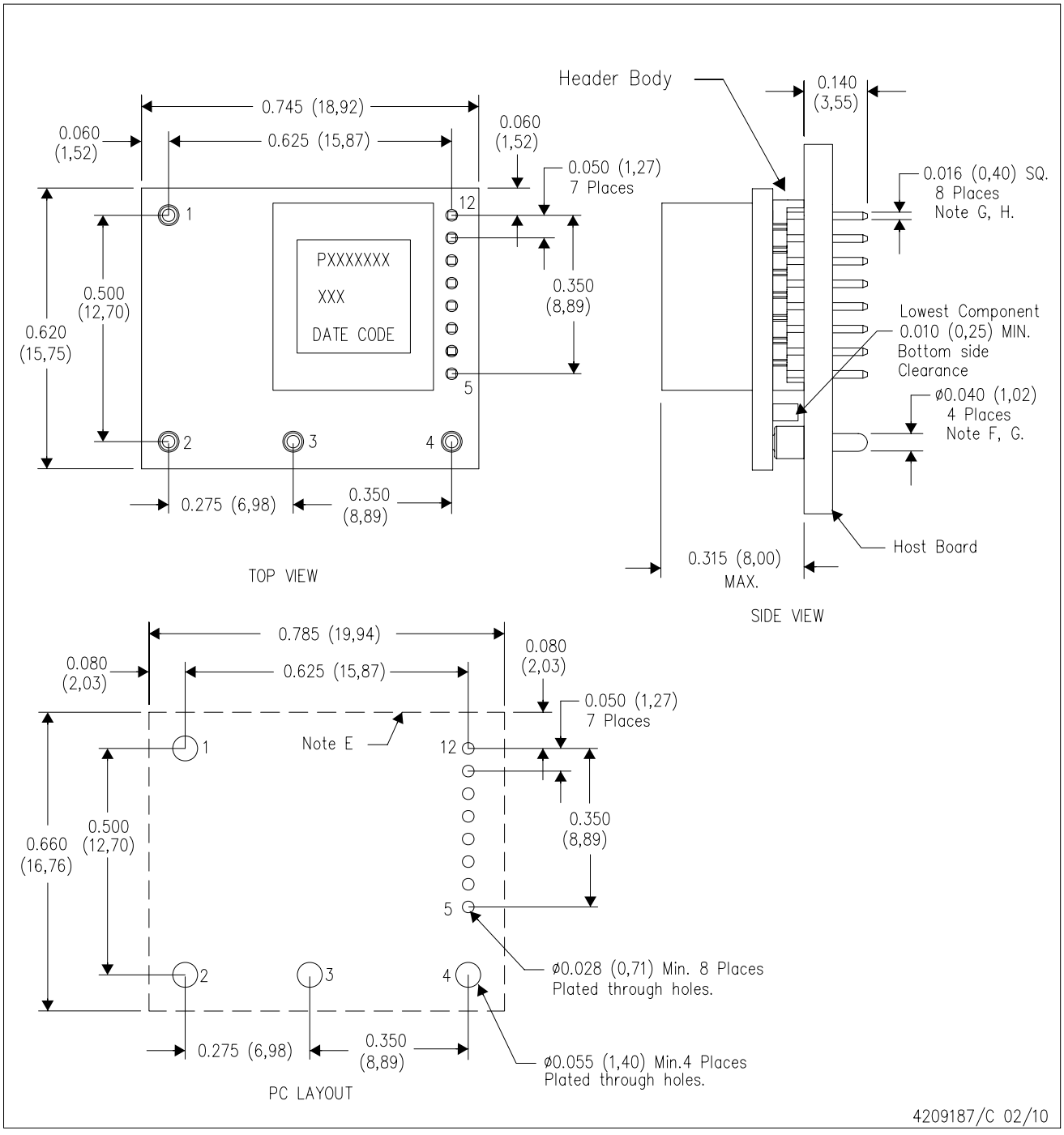
Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/ Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
PTD08A015WAD	ACTIVE	Through-Hole Module	EGS	12	36	Pb-Free (RoHS)	SN	Level-1-235C-UNLIM/ Level-3-260C-168HRS	Request Free Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

EGS (R–PDSS–T12) 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. Header pins are 0.016 (0,40) SQ.
H. All pins: Material – Copper Alloy
Finish – Tin (100%) over Nickel plate

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