TDK

Metamere iAD Series DC/DC Power Modules
6.0-14V Input, 16A Output
SIP Power Module

The iAD Series offers an 80W power module in the industry's standard SIP footprint. The iAD 12Vin series offers an ultra wide input voltage range of 6.0-14.0V. It is highly suitable for use in conjunction with 4:1 and 5:1 unregulated bus converters as well as with fully regulated 12Vout bus converters. The open-frame, compact design provides flexibility by performing local voltage conversion of a 12V bus. The single in-line package is well suited for almost any manufacturing environment.

Features
- Size – 50.8mm x 14 mm x 7.9 mm (2.0 in. x 0.55 in. x 0.31 in.)
- Thru-hole pins 5.08 mm (0.20 in.)
- Maximum weight 12g (0.42 oz)
- Up to 80W of output power in high ambient temperature, low airflow environments with minimal power derating
- Calculated MTBF > 13.7M Hours
- Positive logic on/off
- Flexible Output Voltage Sequencing
- Starts with pre-biased output
- Output voltage adjustment – industry standard
- Constant switching frequency
- Remote Sense
- Full, auto-recovery protection:
  - Input under voltage
  - Short circuit
- ISO Certified manufacturing facilities

Optional Features
- Negative logic on/off
- No output voltage sequencing
- Industry Standard Narrow 9.6V-14V input voltage range
- Short thru-hole pins 3.3 mm (0.13 in.)

Ordering information:

Product Identifier	Package Size	Platform	Input Voltage	Output Current/ Power	Output Units	Main Output Voltage	# of Outputs		Safety Class	Feature Set
i	A	D	12	016	A	008	V	-	0	00
TDK Innoveta	51mmx14mm	Metamere SIP	6V to 14V	016 – 16	Amps	0.8V to 5.5V	Single			00 – Standard

Option Table:

Feature Set	Positive Logic On/Off	Negative Logic On/Off	Input voltage	Sequence	0.13" Pin Length	0.20" Pin Length
00	X		6.0-14.0V	X	X	
01		X	6.0-14.0V	X	X	
02	X		6.0-14.0V		X	
03		X	6.0-14.0V		X	
04	X		6.0-14.0V	X		X
05		X	6.0-14.0V	X		X
06	X		6.0-14.0V			X
07		X	6.0-14.0V			X

Product Offering:

Code	Input Voltage	Output Voltage	Output Current	Maximum Output Power	Efficiency
iAD12016A008V	6.0-14.0V / 9.6-14.0V	0.80V-5.5V	16A	80W	94% (at 5V)

Mechanical Specification:

Dimensions are in mm [in]. Unless otherwise specified tolerances are: x.x ± 0.5 [0.02], x.xx ± 0.25 [0.010]

Recommended Hole Pattern: (Top View)

Pin Assignment:

PIN	FUNCTION	PIN	FUNCTION
1	Vout	6	GND
2	Vout	7	Vin
3	SENSE	8	Vin
4	Vout	9	SEQ
5	GND	10	TRIM
		11	ON/OFF

Pin base material is brass with tin over nickel plating; the maximum module weight is 12g (0.42 oz).

Absolute Maximum Ratings:

Stress in excess of Absolute Maximum Ratings may cause permanent damage to the device.

Characteristic	Min	Max	Unit	Notes & Conditions
Continuous Input Voltage	-0.25	15	Vdc	
Storage Temperature	-55	125	˚C	
Operating Temperature Range (Tc)	-40	125*	˚C	Measured at the location specified in the thermal measurement figure; maximum temperature varies with output current – see curve in the thermal performance section of the data sheet.

* Engineering estimate

Input Characteristics:

Unless otherwise specified, specifications apply over all rated Input Voltage, Resistive Load, and Temperature conditions.

Characteristic	Min	Typ	Max	Unit	Notes & Conditions
Operating Input Voltage (3.63Vand lower outputs)	6.0	---	14.0	Vdc	-000 through -007
Operating Input Voltage (greater than 3.63V outputs)	8.3	---	14.0	Vdc	-000 through -007
Maximum Input Current	---	---	18	A	Vin = 6.0 to Vin,max
Startup Delay Time from application of input voltage	---	4	---	mS	Vo = 0 to 0.1*Vo,nom; on/off =on, Io=Io,max, Tc=25˚C
Startup Delay Time from on/off	---	3	---	mS	Vo = 0 to 0.1*Vo,nom; Vin = Vi,nom, Io=Io,max,Tc=25˚C
Output Voltage Rise Time	---	5	---	mS	Io=Io,max,Tc=25˚C, Vo=0.1 to 0.9*Vo,nom
Input Reflected Ripple	---	30	---	mApp	See input/output ripple measurement figure; BW = 20 MHz
Input Ripple Rejection	---	60	---	dB	@ 120 Hz
Turn on input voltage	---	4.9	---	V	-000 through -007
Turn off input voltage	---	4.3	---	V	-000 through -007

*Engineering Estimate

Caution: The power modules are not internally fused. An external input line normal blow fuse with a maximum value of 30A is required, see the Safety Considerations section of the data sheet.
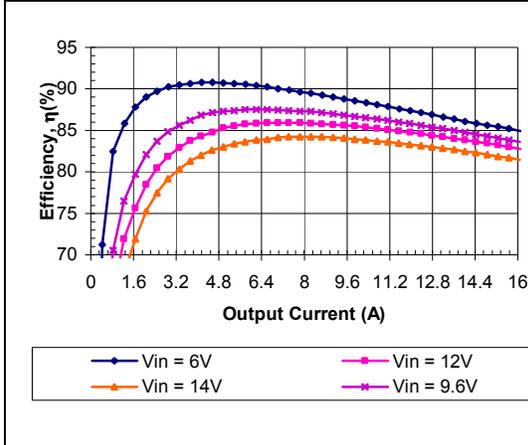
Electrical Data:

| Characteristic		Min	Typ	Max	Unit	Notes & Conditions
Output Voltage Initial Setpoint		-2	-	+2	%	Vin=Vin,nom; Io=Io,max; Tc = 25˚C
Output Voltage Tolerance		-2.5	-	+3.5	%	Over all rated input voltage, load, and temperature conditions to end of life
Efficiency	Vo = 1.2V	---	83	---	%	Vin= 12.0V; Io=Io,max; Tc = 25˚C
	Vo = 1.5V	---	85	---	%	
	Vo = 1.8V	---	87	---	%	
	Vo = 2.5V	---	90	---	%	
	Vo = 3.3V	---	92	---	%	
	Vo = 5.0V	---	94	---	%	
Line Regulation		---	6	15*	mV	Vin=Vin,min to Vin,max
Load Regulation		---	10	22*	mV	Io=Io,min to Io,max
Temperature Regulation		---	18	40*	mV	Tc=Tc,min to Tc,max
Output Current		0	---	16	A	
Output Current Limiting Threshold		---	28	---	A	Vo = 0.9*Vo,nom, Tc<Tc,max)
Short Circuit Current		---	0.3	---	A	Vo = 0.25V, Tc = 25˚C
Output Ripple and Noise Voltage		---	30	100*	mVpp	Measured across one 0.1 uF ceramic capacitor and one 47uF ceramic capacitor – see input/output ripple measurement figure; BW = 20MHz.
		---	6	---	mVrms	
Output Voltage Adjustment Range		0.8	---	5.5	V	
Output Voltage Sense Range		---	---	0.5	V	
Dynamic Response: Recovery Time		---	30	---	uS	di/dt =2.5A/uS, Vin=Vin,nom; load step from 50% to 100% of Io,max
Transient Voltage		---	200	---	mV	
Switching Frequency		---	315	---	kHz	Fixed
External Load Capacitance		0	---	5000*&	uF	
Vref			0.7		V	Required for trim calculation
F			15000		Ω	Required for trim calculation
G			1000		Ω	Required for trim calculation

*Engineering Estimate
& Contact TDK Innoveta for applications that require additional capacitance or very low esr
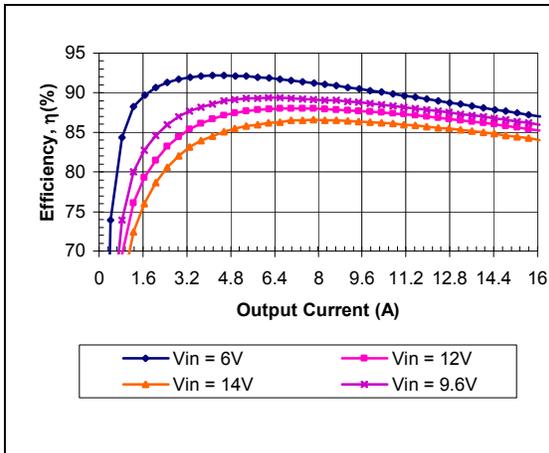
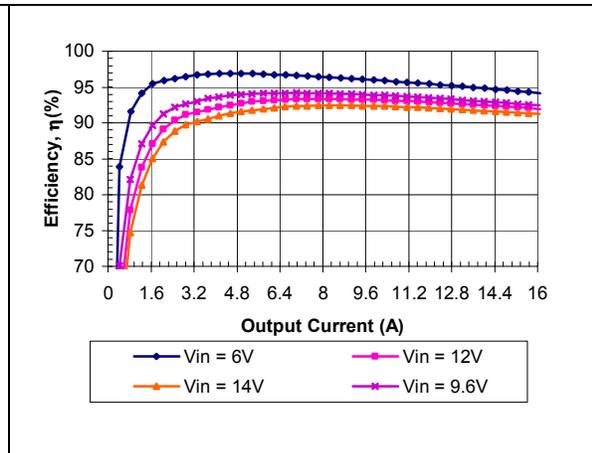## Electrical Characteristics:

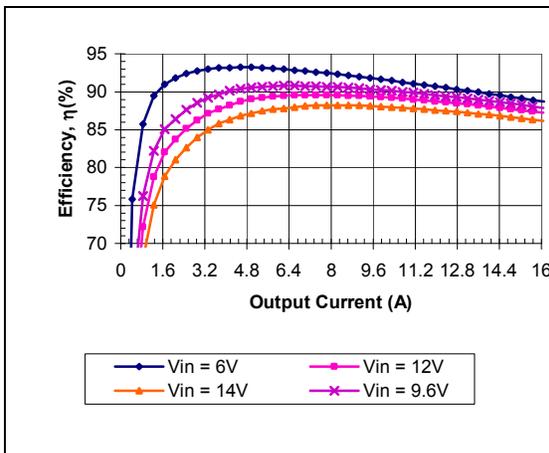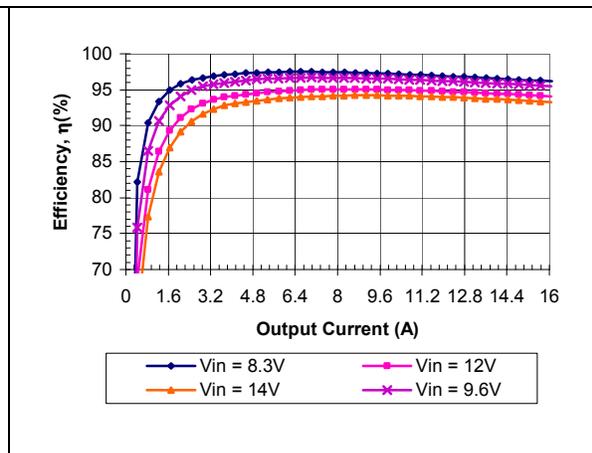### Typical Efficiency vs. Input Voltage
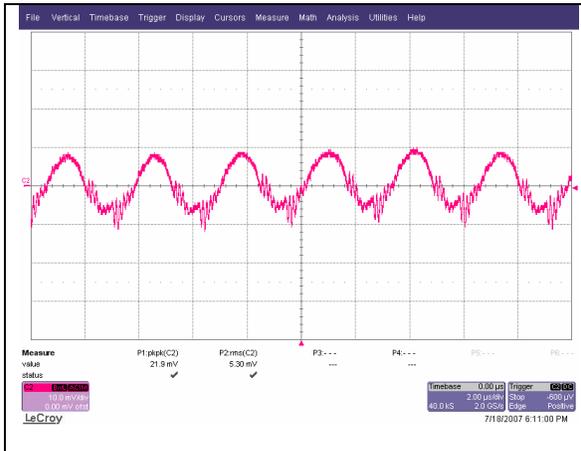

Vo=1.2V
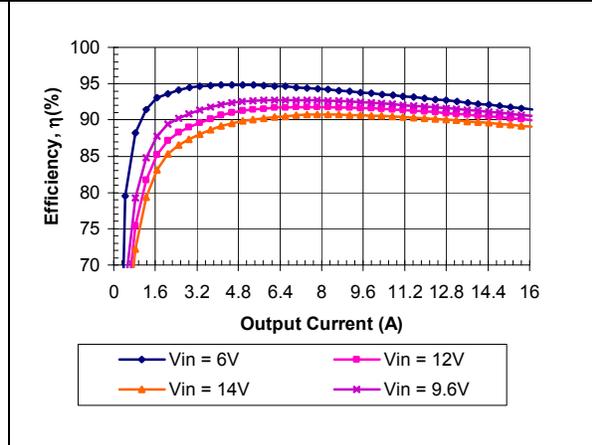
Vo=2.5V

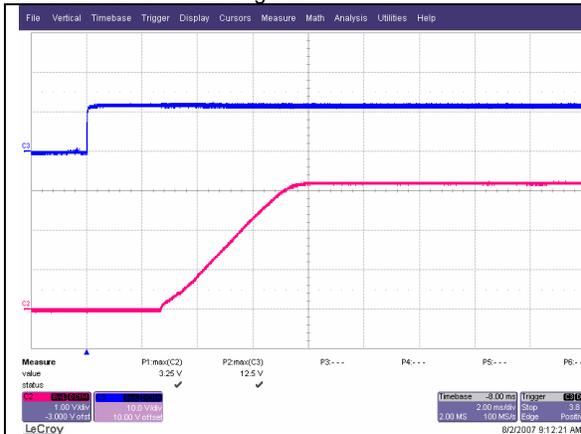Vo=1.5V

Vo=3.3V

Vo=1.8V

Vo=5V

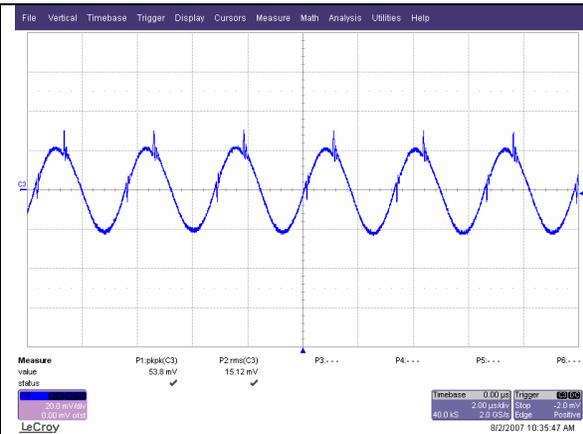## Electrical Characteristics (continued):

Vo=3.3V Typical Output Ripple at nominal Input voltage and full load at Ta=25 degrees

Typical Output Short Circuit Current

Vo=3.3V Typical startup characteristic from on/off at full load. Upper trace - on/off signal, lower trace – output voltage

Vo=3.3V Typical Input Ripple at nominal Input Voltage and full load at Ta=25 degrees. Input capacitors - 2x150uF aluminum and 2x47uF ceramic
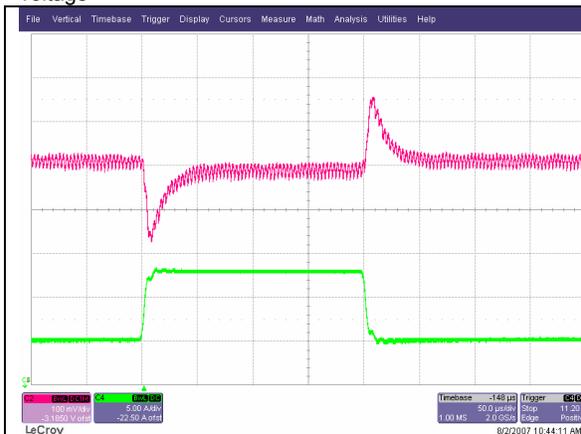
Vo=3.3V Typical output voltage transient response to load step from 50% to 100% of full load with output current slew rate of 2.5A/uS
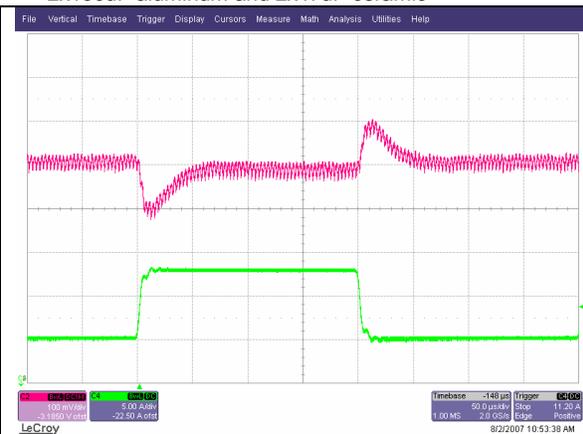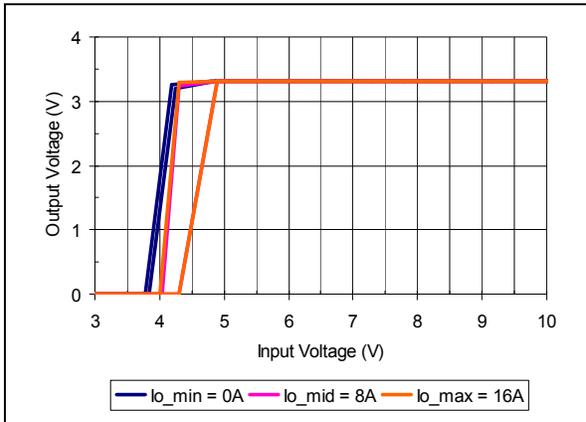

Vo=3.3V Typical output voltage transient response to load step from 50% to 100% of full load with output current slew rate of 2.5A/uS.   (Cext = 2x150uF polymer capacitors)
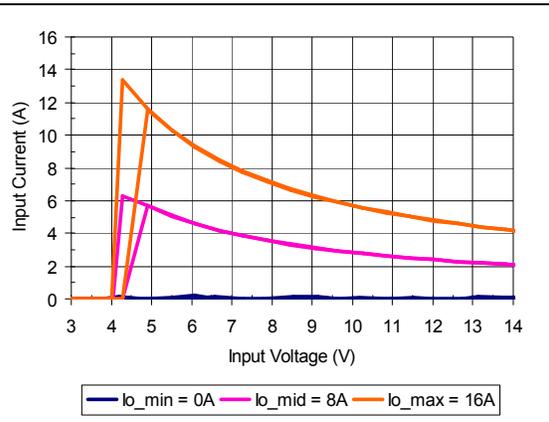
Electrical Characteristics (continued):

Typical Output Voltage vs. Input Voltage Characteristics
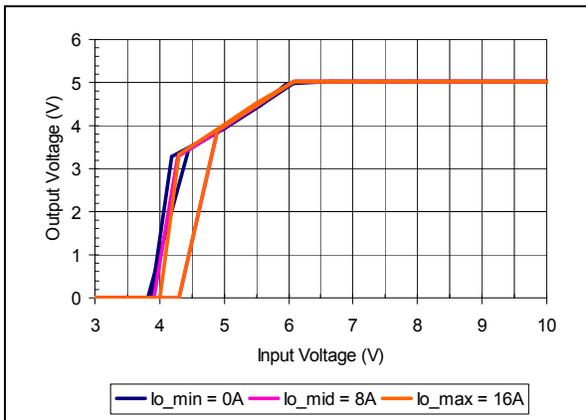
Option Code: -000 through -007
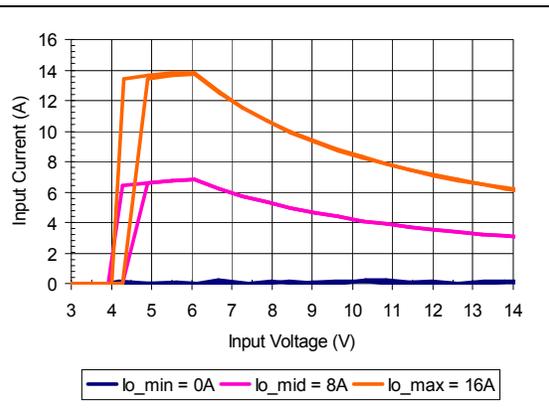**(Input voltage range : 6.0V to 14V)**

Vo=3.3V Typical Output Voltage vs. Input Voltage
Characteristics

Vo=3.3V Typical Input Current vs. Input Voltage
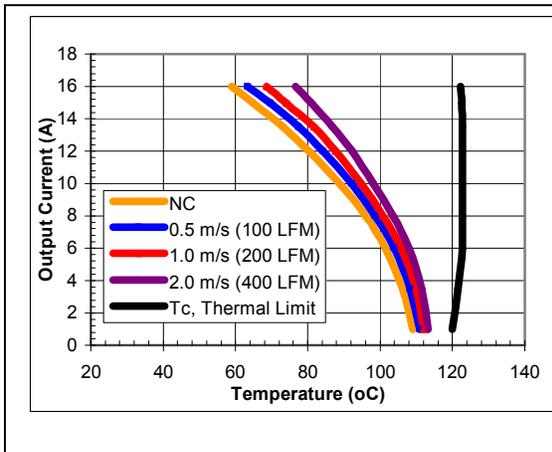Characteristics

Vo=5V Typical Output Voltage vs. Input Voltage
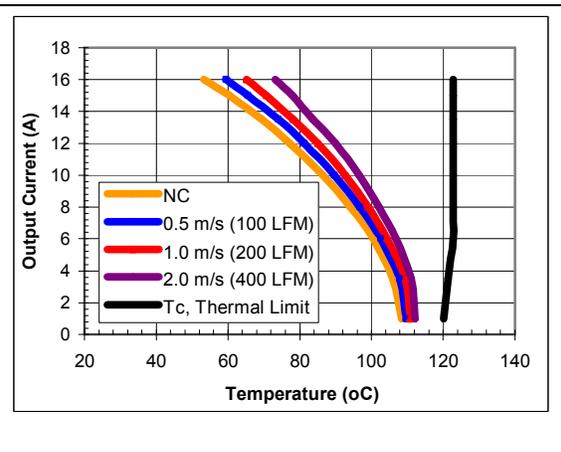Characteristics

Vo=5V Typical Input Current vs. Input Voltage
Characteristics

Thermal Performance:

Vo=3.3V, Vin=12V maximum output current vs. ambient temperature at nominal input voltage for airflow rates natural convection to 400lfm with airflow from pin 2 to pin 3 (Best Direction).

Vo=5V, Vin=12V maximum output current vs. ambient temperature at nominal input voltage for airflow rates natural convection to 400lfm with airflow from pin 2 to pin 3 (Best Direction).
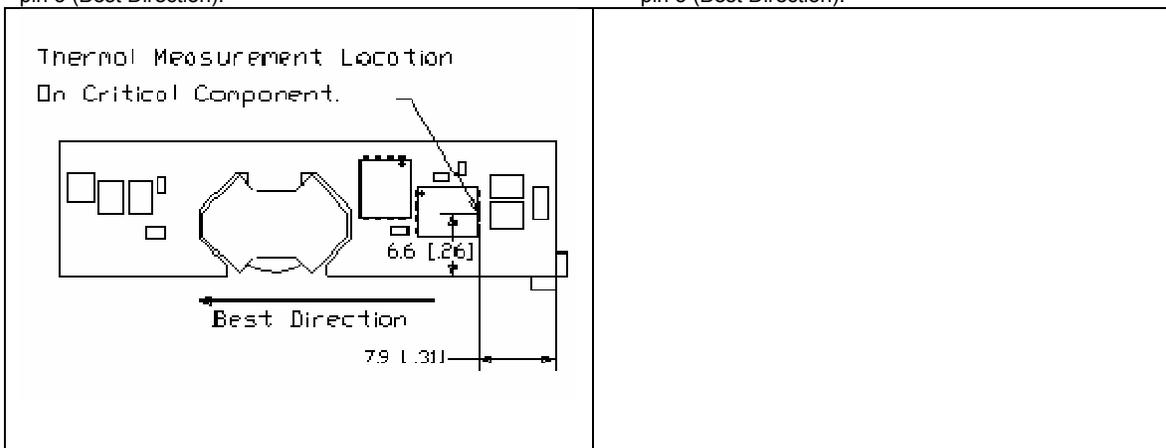
iAD12016A008V thermal measurement location and airflow orientation – top view

The thermal curves provided are based upon measurements made in TDK Innoveta's experimental test setup that is described in the Thermal Management section. Due to the large number of variables in system design, TDK Innoveta recommends that the user verify the module's thermal performance in the end application. The critical component should be thermo coupled and monitored, and should not exceed the temperature limit specified in the derating curve above. It is critical that the thermocouple be mounted in a manner that gives direct thermal contact or significant measurement errors may result. TDK Innoveta can provide modules with a thermocouple pre-mounted to the critical component for system verification tests.

Thermal Management:

An important part of the overall system design process is thermal management; thermal design must be considered at all levels to ensure good reliability and lifetime of the final system. Superior thermal design and the ability to operate in severe application environments are key elements of a robust, reliable power module.

A finite amount of heat must be dissipated from the power module to the surrounding environment. This heat is transferred by the three modes of heat transfer: convection, conduction and radiation. While all three modes of heat transfer are present in every application, convection is the dominant mode of heat transfer in most applications. However, to ensure adequate cooling and proper operation, all three modes should be considered in a final system configuration.

The open frame design of the power module provides an air path to individual components. This air path improves convection cooling to the surrounding environment, which reduces areas of heat concentration and resulting hot spots.

Test Setup: The thermal performance data of the power module is based upon measurements obtained from a wind tunnel test with the setup shown in the wind tunnel figure. This thermal test setup replicates the typical thermal environments encountered in most modern electronic systems with distributed power architectures. The electronic equipment in networking, telecom, wireless, and advanced computer systems operates in similar environments and utilizes vertically mounted PCBs or circuit cards in cabinet racks.

The power module, as shown in the figure, is mounted on a printed circuit board (PCB) and is vertically oriented within the wind tunnel. The cross section of the airflow passage is rectangular. The spacing between the top of the module and a parallel facing PCB is kept at a constant (0.5 in). The power module's orientation with respect to the airflow direction can have a significant impact on the module's thermal performance.

Thermal Derating: For proper application of the power module in a given thermal environment, output current derating curves are provided as a design guideline on the Thermal Performance section for the power module of interest. The module temperature should be measured in the final system configuration to ensure proper thermal management of the power module. For thermal performance verification, the module temperature should be measured at the component indicated in the thermal measurement location figure on the thermal performance page for the power module of interest. In all conditions, the power module should be operated below the maximum operating temperature shown on the derating curve. For improved design margins and enhanced system reliability, the power module may be operated at temperatures below the maximum rated operating temperature.
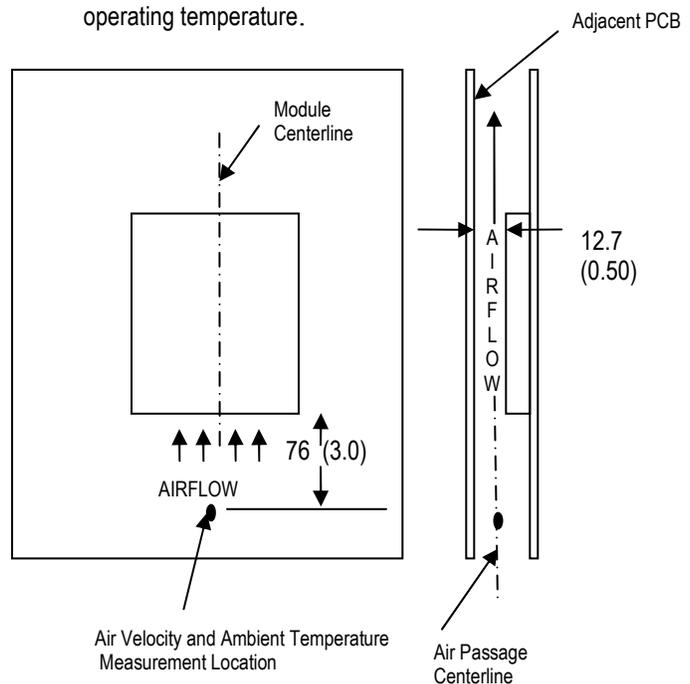
**Wind Tunnel Test Setup Figure** Dimensions are in millimeters and (inches).

Heat transfer by convection can be enhanced by increasing the airflow rate that the power module experiences. The maximum output current of the power module is a function of ambient temperature (T_{AMB}) and airflow rate as shown in the thermal performance figures on the thermal performance page for the power module of interest. The curves in the figures are shown for natural convection through 2 m/s (400 ft/min). The data for the natural convection condition has been collected at 0.3 m/s (60 ft/min) of airflow, which is the typical airflow generated by other heat dissipating components in many of the systems that these types of modules are used in. In the final system configurations, the airflow rate for the natural convection condition can vary due to temperature gradients from other heat dissipating components.

Operating Information:

Over-Current Protection: The power modules have short circuit protection to protect the module during severe overload conditions. During overload conditions, the power modules may protect themselves by entering a hiccup current limit mode. The modules will operate normally once the output current returns to the specified operating range.

Remote On/Off: - The power modules have an internal remote on/off circuit. The user must supply an open-collector or compatible switch between the GND pin and the on/off pin. The maximum voltage generated by the power module at the on/off terminal is 15V. The maximum allowable leakage current of the switch is 10uA. The switch must be capable of maintaining a low signal Von/off < 0.3V while sinking 1mA.

The standard on/off logic is positive logic. The power module will turn on if terminal 10 (on/off) is left open and will be off if terminal 10 is connected to terminal GND. If the positive logic circuit is not being used, terminal 10 should be left open.
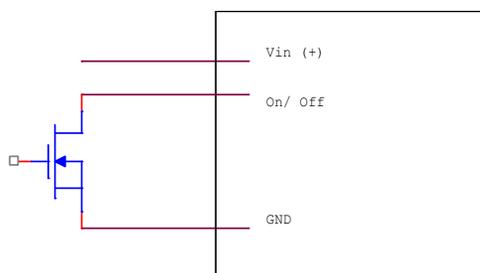
On/Off Circuit for positive logic

An optional negative logic is available. In the circuit configuration shown the power module will turn on if the external switch is on and it will be off if the on/off pin is pulled up to Vin by an external 40Kohm resistor. If the negative logic feature is not being used, terminal 10 should be left open.
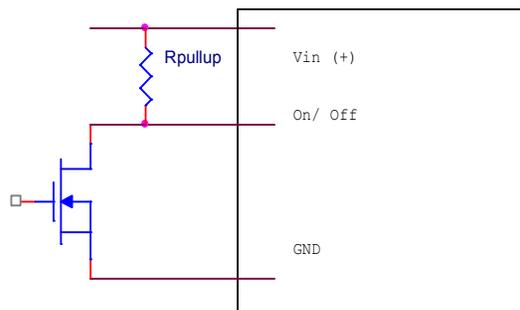

On/Off Circuit for negative logic

Remote Sense: The power modules feature remote sense to compensate for the effect of output distribution drops. The output voltage sense range defines the maximum voltage allowed between the output power terminals and output sense terminals, and it is found on the electrical data page for the power module of interest. If the remote sense feature is not being used, the Sense terminal should be connected to the Vo terminal.

The output voltage at the Vo terminal can be increased by either the remote sense or the output voltage adjustment feature. The maximum voltage increase allowed is the larger of the remote sense range or the output voltage adjustment range; it is not the sum of both.

As the output voltage increases due to the use of the remote sense, the maximum output current may need to be decreased for the power module to remain below its maximum power rating.

Output Voltage Adjustment: The output voltage of the power module may be adjusted by using an external resistor connected between the Vout trim terminal and GND terminal. If the output voltage adjustment feature is not used, trim terminal should be left open. Care should be taken to avoid injecting noise into the power module's trim pin. A small 0.01uF capacitor between the power module's trim pin and GND pin may help avoid this.
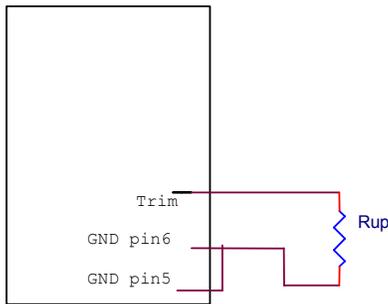
Circuit to increase output voltage

The circuit configuration for output voltage adjustment is shown in the figure above. Rtrim should be placed as close to pin 6 (GND) as possible. The trace connecting pin 6 to Rtrim should not carry significant current in order to prevent a voltage drop that will impact the output voltage accuracy. Pin5 and Pin6 ground pins should be connected with a short, direct trace or ground plane.

To adjust the output voltage from Vo,nom to Vo,up the trim resistor should be chosen according to the following equation:

$$Ru := \left[\frac{(Vref \cdot F)}{(Voup - Vonom)} - G \right]$$

The values of Vref, F, and G are found in the electrical data section for the power module of interest. The maximum power available from the power module is fixed. As the output voltage is trimmed up, the maximum output current must be decreased to maintain the maximum rated power of the module.

e.g. Vo = 1.8V

$$Ru := \left\lfloor \frac{0.7 \cdot 15000}{(1.8 - 0.7525)} - 1000 \right\rfloor$$

Vout (V)	Ru (Kohm)
1.2	22.46
1.5	13.05
1.8	9.024
2.5	5.009
3.3	3.122
5.0	1.472

Voltage Sequencing:

Some iAD power modules include a voltage sequencing feature. The voltage sequencing feature enables the user to implement various types of power up and power down sequencing schemes including sequential startup, ratiometric startup, and simultaneous startup. If the sequencing feature is not being used the Seq pin should be left open or tied to Vin. When the voltage sequencing feature is used the pre-bias immunity feature is disabled.

To use the voltage sequencing feature, the module should be set to an On state using the on/off feature. The input voltage should be applied and in the specified operating range for 10mS during which a 50mV voltage potential should be maintained on the Seq pin. After the 10mS interval, an analog voltage can be applied to the Seq pin and the output of the module will track the applied voltage on a one to one basis until the output reaches its set point voltage. The final sequencing voltage must be higher than the module set point. For sequential shut down, the Seq pin voltage should be lowered. The module output voltage will decrease on a one to one basis.

There is a brief time delay before the output voltage mimics the Seq pin voltage. If needed, the impact of this time delay can be minimized by limiting the slew rate of the voltage on the Seq pin to less than 0.5 V/ms.

For assistance using the voltage sequencing function, please contact TDK Innoveta technical support.

EMC Considerations: TDK Innoveta power modules are designed for use in a wide variety of systems and applications. For assistance with designing for EMC compliance, please contact TDK Innoveta technical support.

Input Impedance:
The source impedance of the power feeding the DC/DC converter module will interact with the DC/DC converter. To minimize the interaction, low-esr capacitors should be located at the input to the module. Data is provided on the electrical characteristics page, showing the typical input ripple voltage with two 47uF ceramic capacitors and two 150uF aluminum capacitors.

Reliability:

The power modules are designed using TDK Innoveta's stringent design guidelines for component derating, product qualification, and design reviews. The MTBF is calculated to be greater than 13.7M hours at full output power and Ta = 40˚C using the Telcordia SR-332 calculation method.

Quality:

TDK Innoveta's product development process incorporates advanced quality planning tools such as FMEA and Cpk analysis to ensure designs are robust and reliable. All products are assembled at ISO certified assembly plants.

Input/Output Ripple and Noise Measurements:
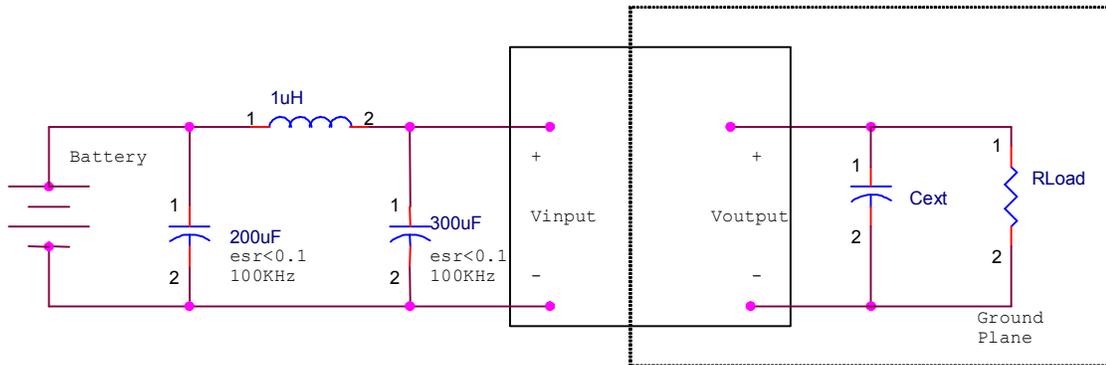
The input reflected ripple is measured with a current probe and oscilloscope. The ripple current is the current through the 1uH inductor.

The output ripple measurement is made approximately 9 cm (3.5 in.) from the power module using an oscilloscope and BNC socket. The capacitor Cext is located about 5 cm (2 in.) from the power module; its value varies from code to code and is found on the electrical data page for the power module of interest under the ripple & noise voltage specification in the Notes & Conditions column.

Safety Considerations:

As of the publishing date, certain safety agency approvals may have been received on the iAD series and others may still be pending. Check with TDK Innoveta for the latest status of safety approvals on the iAD product line.

For safety agency approval of the system in which the DC-DC power module is installed, the power module must be installed in compliance with the creepage and clearance requirements of the safety agency.

To preserve maximum flexibility, the power modules are not internally fused. An external input line normal

blow fuse with a maximum value of 30A is required by safety agencies. A lower value fuse can be selected based upon the maximum dc input current and maximum inrush energy of the power module.

Warranty:

TDK Innoveta's comprehensive line of power solutions includes efficient, high-density DC-DC converters. TDK Innoveta offers a three-year limited warranty. Complete warranty information is listed on our web site or is available upon request from TDK Innoveta.

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