Veta® iHD SERIES DC-DC POWER MODULES
24V Input, 28V/8A Output
Half-Brick

The Veta® iHD Series power modules operate over a wide 18 – 36Vdc input voltage range and provide one regulated dc output voltage that is electrically isolated from the input. Its 92% efficiency and superior thermal performance make the Veta® Family of power modules ideally suited for power-hungry applications in demanding thermal environments. This rugged building block is designed to serve as the core of your high reliability system. A wide output voltage trim range, -50 to +10%, and remote sensing are standard features enhancing versatility. The Veta® iHD platform also offers standard active current sharing for applications requiring N+1 or parallel operation

Standard Features:

- Standard Half Brick footprint
- High efficiency, 92% typical
- Wide output trim voltage
- True 8A product at 28V output
- Industry-leading output power: 225W
- Monotonic start-up
- Monotonic start-up into a pre-biased output
- Single wire active current sharing referenced to the secondary
- Basic insulation – 1500 Vdc
- Constant switching frequency
- Synchronization to an external clock signal
- Auto-recovery protection:
    - Input under and over voltage
    - Current limit
    - Short circuit
    - Thermal limit
- Latched output over voltage
- High reliability open frame, surface-mount construction
- Baseplate for improved thermal management
- Safety agency approvals pending
- Multiple patents pending

Optional Features:

- Remote on/off (negative logic)
- Short Thru-hole pins 2.79 mm (0.110”)

Ordering information:

Product Identifier	Package Size	Platform	Input Voltage	Output Current/ Power	Output Units	Main Output Voltage	# of Outputs		Safety Class	Feature Set
i	H	D	24	008	A	280	V	-	0	00
TDK Innoveta	Half Brick	Veta®	18-36V	8	Amps	280 – 28V	Single			00 – Standard

Feature Set	On/Off Logic	Pin Length
00	Positive	0.145”
01	Negative	0.145”
04	Positive	0.110”
05	Negative	0.110”

Product Offering:

Code	Input Voltage	Output Voltage	Output Current	Maximum Output Power	Efficiency
iHD24008A280V-000	18V to 36V	28V	8A	225W	92%

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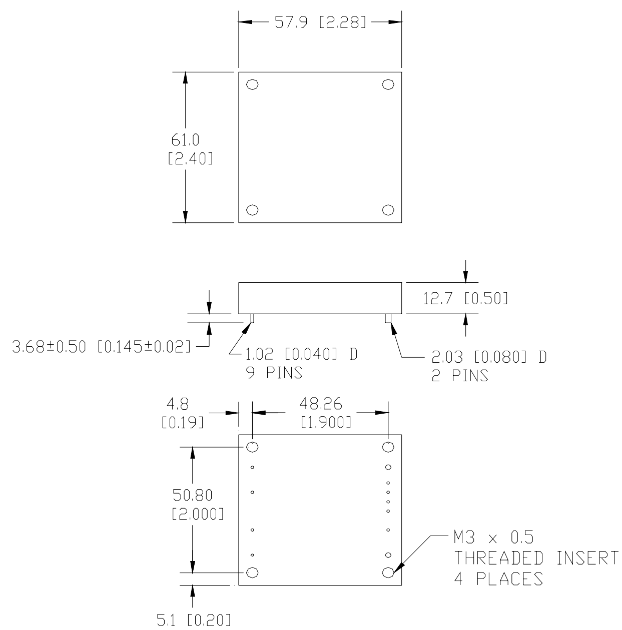
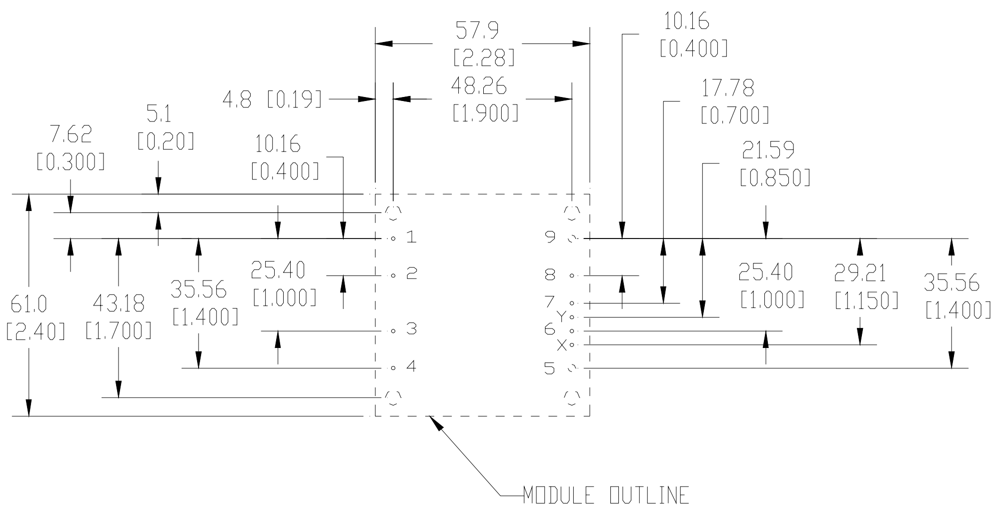
Mechanical Specification:

Unless otherwise specified tolerances are: x.x ± 0.5 mm [x.xx ± 0.02 in.], x.xx +/- 0.25 mm [x.xxx +/- 0.010 in.]



Recommended Hole Pattern: (top view)



Pin Assignment:

PIN	FUNCTION	PIN	FUNCTION
1	Vin (+)	7	Trim
2	On/Off	8	Sense (+)
3	Case (Ishare – optional)	9	Vout (+)
4	Vin (-)	x	Sync
5	Vout (-)	y	Ishare
6	Sense (-)		

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	-0.5	50	Vdc	
Isolation Voltage	---	1500	Vdc	
Storage Temperature	-55	125	˚C	
Operating Temperature Range (Tc)	-40	110*	˚C	Maximum base plate temperature. Measured at the location specified in the thermal measurement figure.

* 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	18	24	36	Vdc	
Maximum Input Current	---	---	15*	A	Vin = 0 to Vin,max, Io=8A, Vo=Vo,nom
Turn-on Voltage	---	17.3	---	Vdc	
Turn-off Voltage	---	17.0	---	Vdc	
Hysteresis	---	0.3	---	Vdc	
Input High Voltage Turn-off	---	37.2	---	Vdc	
Input High Voltage Turn-on	---	36.6	---	Vdc	
Hysteresis	---	0.6	---	Vdc	
Startup Delay Time from application of input voltage	---	15	---	mS	Vo = 0 to 0.1*Vo,nom; on/off =on, Io=Io,max, Tc=25˚C
Startup Delay Time from on/off	---	10	---	mS	Vo = 0 to 0.1*Vo,nom; Vin = Vi,nom, Io=Io,max,Tc=25˚C
Output Voltage Rise Time	---	20	---	mS	Io=Io,max,Tc=25˚C, Vo=0.1 to 0.9*Vo,nom
Inrush Transient	---	---	0.02	A^2s	
Input Reflected Ripple	---	6.9	---	mApp	See input/output ripple measurement figure; BW = 20 MHz
Input Ripple Rejection	---	37	---	dB	@120Hz

*Engineering Estimate

Caution: The power modules are not internally fused. An external input line normal blow fuse with a maximum value of 20A is required, see the Safety Considerations section of the data sheet.

Electrical Data:

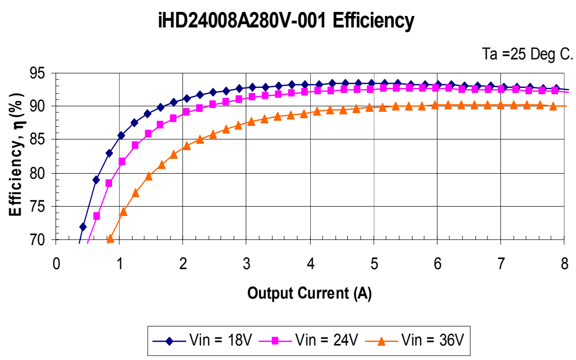
iHD24008A280V-000 through -007: 28V, 8A Output

Characteristic	Min	Typ	Max	Unit	Notes & Conditions
Output Voltage Initial Setpoint	27.5	28	28.5	Vdc	Vin=Vin,nom; Io=Io,max; Tc = 25˚C
Output Voltage Tolerance	27.1	---	28.9	Vdc	Over all rated input voltage, load, and temperature conditions to end of life
Efficiency	---	92	---	%	Vin=Vin,nom; Io=Io,max; Tc = 25˚C
Line Regulation	---	10	30*	mV	Vin=Vin,min to Vin,max
Load Regulation	---	10	50*	mV	Io=Io,min to Io,max
Temperature Regulation	---	85	200*	mV	Tc=Tc,min to Tc,max
Output Current	0.8	---	8	A	At loads less than Io,min the module will continue to regulate the output voltage, but the output ripple may increase
Output Current Limiting Threshold	8.1	10.1	12.0	A	Vo = 0.9*Vo,nom, Tc<Tc,max
Short Circuit Current	---	10.1	---	A	Vo = 0.25V, Tc = 25˚C
Output Ripple and Noise Voltage	---	300	475	mVpp	Measured across one 200uF electrolytic capacitor, one 10uF, one 1uF and one 0.1uF ceramic capacitors – see input/output ripple measurement figure; BW = 20MHz
	---	90	150	mVrms	
Output Voltage Adjustment Range	50	---	110	%Vo,nom	
Output Voltage Sense Range	---	---	10	%Vo,nom	
Dynamic Response: Recovery Time	---	0.25	---	mS	di/dt = 0.1A/uS, Vin=Vin,nom; load step from 50% to 75% of Io,max with 200uF ext. cap
Transient Voltage	---	270	---	mV	
Output Voltage Overshoot during startup	---	0	---	mV	Io=Io,max,Tc=25˚C
Switching Frequency	---	300	---	kHz	Fixed
Current Sharing Accuracy***	---	8	---	%	% of max output current of a single module
Output Over Voltage Protection	---	33.0	---	V	
External Load Capacitance	200	---	2000**	uF	
Isolation Capacitance	---	2000	---	pF	
Isolation Resistance	10	---	---	MΩ	
Vref		1.225		V	Required for trim calculation

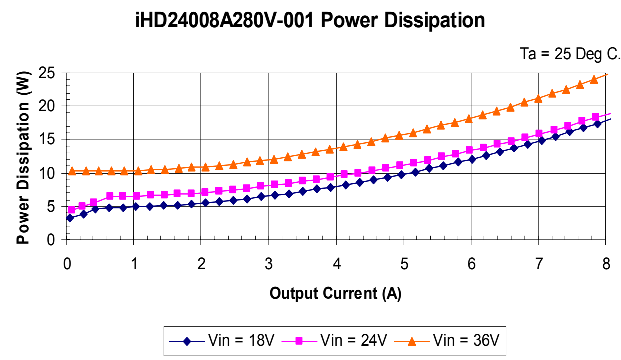
* Engineering Estimate
** Contact Innoveta for applications that require additional capacitance
*** Defined as |Io1-Io2|/(2*Iomax)

Electrical Characteristics:

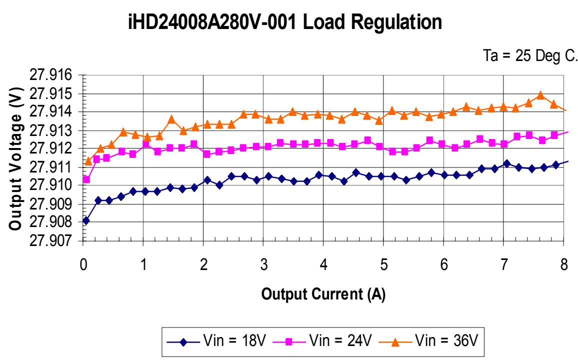
iHD24008A280V-000 through -007: 28V, 8A Output



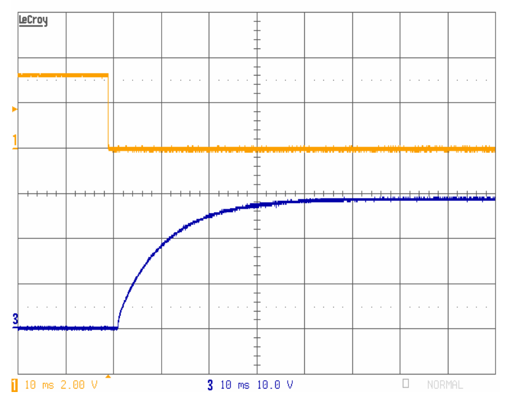
iHD24008A280V-001 Typical Efficiency vs. Output Current at Ta=25 degrees.



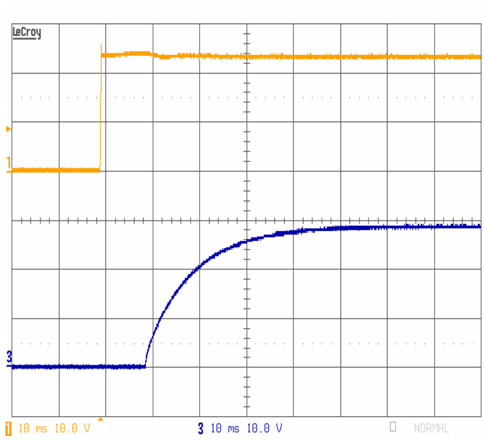
iHD24008A280V-001 Typical Power Dissipation vs. Output current at Ta=25 degrees



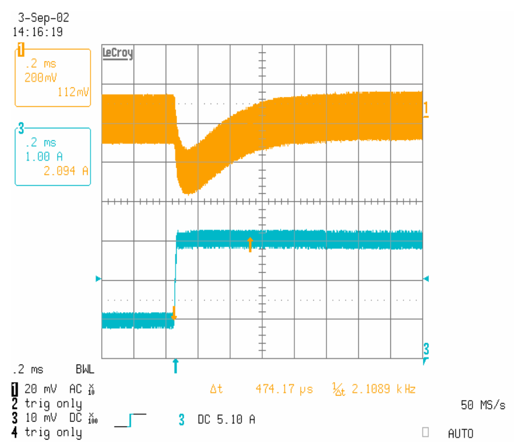
iHD24008A280V-001 Typical Output Voltage vs. Load Current at Ta = 25 degrees



iHD24008A280V-001 Typical startup characteristic from on/off at full load. Upper trace - on/off signal, lower trace – output voltage



iHD24008A280V-001 Typical startup characteristic from input voltage application at full load. Upper trace - input voltage, lower trace – output voltage



iHD24008A280V-001 Typical transient response. Load step from 50% to 75% of full load with 0.1A/uS. Lower trace – output current , upper trace – output voltage

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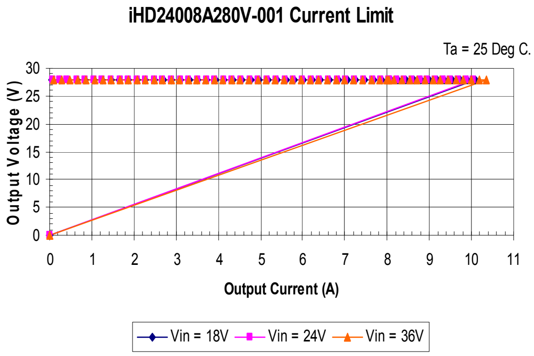
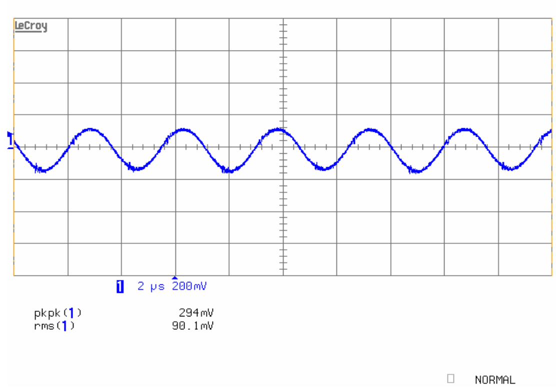
Electrical Characteristics (continued):

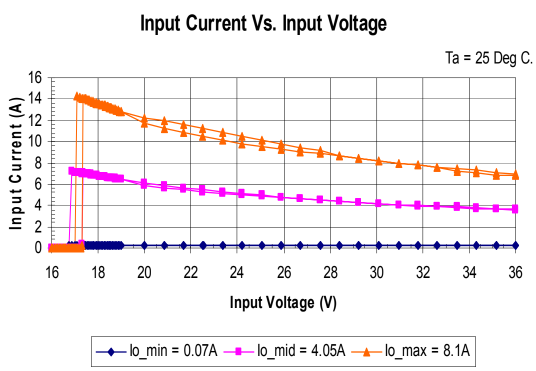
iHD24008A280V-000 through -007: 28V, 8A Output



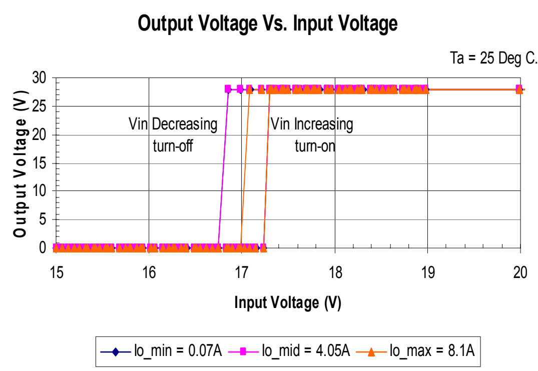
iHD24008A280V-001 Typical Output Current Limit Characteristics vs. Input Voltage at Ta=25 degrees.



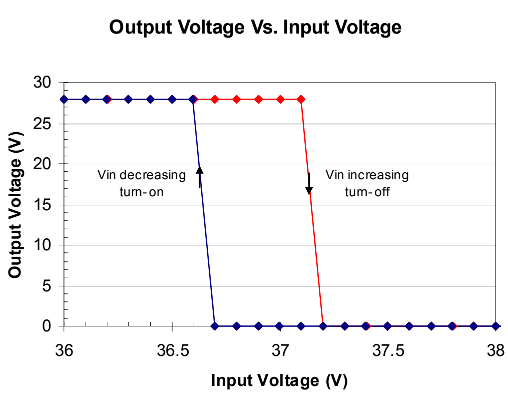
iHD24008A280V-001 Typical Output Ripple at nominal Input voltage and full load with external capacitors 200uF Al +10uF+1uF+0.1uF ceramic at Ta=25 degrees



iHD24008A280V-001 Typical Input Current vs. Input Voltage Characteristics at Ta=25 degrees.



iHD24008A280V-001 Typical Output Voltage vs. Input Voltage Turn-on / Turn-off Characteristics – low voltage at Ta=25 degrees.



iHD24008A280V-001 Typical Output Voltage vs. Input Voltage Turn-on/ Turn-off Characteristics – high voltage at Ta=25 degrees.

% Change of Vout	Trim Down Resistor (Kohm)	% Change of Vout	Trim Up Resistor (Kohm)
-3%	31.33K	+3%	749.4K
-5%	18K	+5%	458.0K
-10%	8K	+10%	239.43K

e.g. trim up 5%

$$R_{up} = \frac{\left[\frac{28}{1.225} - 2\right] \cdot (1 + 5\%) + 1}{5\%} = 458.0\,(k\Omega)$$

iHD24008A280V-001 Calculated resistor values for output voltage adjustment.

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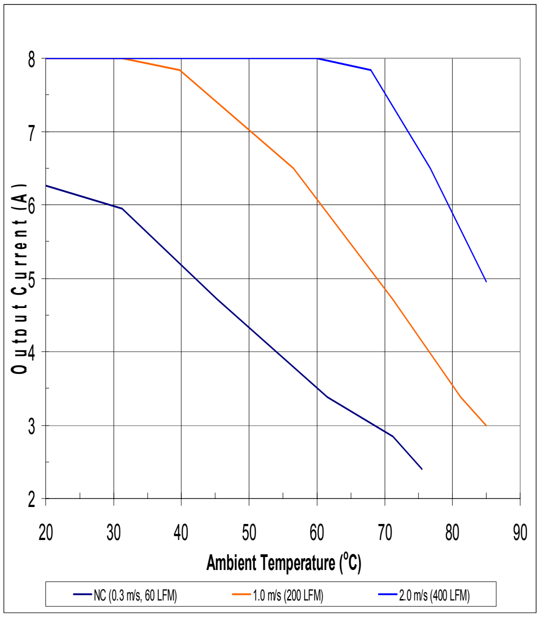
Thermal Performance:

iHD24008A280V-000 through -007: 28V, 8A Output



iHD24008A280V-001 maximum output current vs. ambient temperature at nominal input voltage for airflow rates natural convection 0.3 m/s (60lfm) to 2.0m/s (400lfm) with airflow from output to input.

Thermal Management:

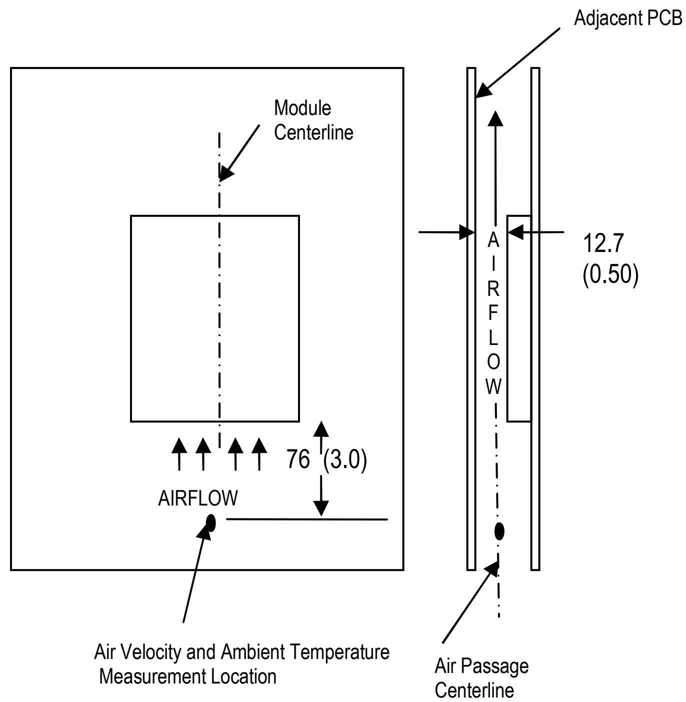
An important part of the overall system design process is thermal management; thermal design must be considered at all levels to ensure good reliability and lifetime of the final system. Superior thermal design and the ability to operate in severe application environments are key elements of a robust,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



Wind Tunnel Test Setup Figure Dimensions are in millimeters (inches).

Thermal Derating: For proper application of the power module in a given thermal environment, output current derating curves are provided as a design guideline in 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. 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.

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 section. The curves in the figures are shown for natural convection through 3 m/s (600 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

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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 current limit protection to protect the module during output overload and short circuit 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. There is a typical delay of 2mS from the time an overload condition appears at the module output until the hiccup mode will occur.

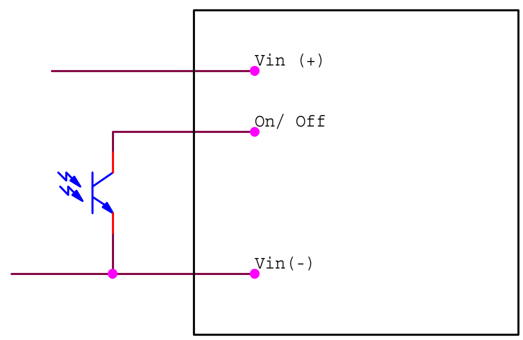
Output Over-Voltage Protection: The power modules have a control circuit, independent of the primary control loop that reduces the risk of over voltage appearing at the output of the power module during a fault condition. If there is a fault in the primary regulation loop, the over voltage protection circuitry will cause the power module to shut down. The module remains off unless either the input power is recycled or the on/off switch is toggled.

For modules with Vo,nom ≤ 12.0V, the iHD Veta® family also offers, as an option, hiccup over-voltage protection. The hiccup mode starts when the output voltage has reached the level indicated in the Electrical Data section for the power module of interest. When the condition causing the over-voltage is corrected, the module will operate normally.

Thermal Protection: When the power modules exceed the maximum operating temperature, the modules may turn-off to safeguard the power unit against thermal damage. The module will auto restart as the unit is cooled below the over temperature threshold.

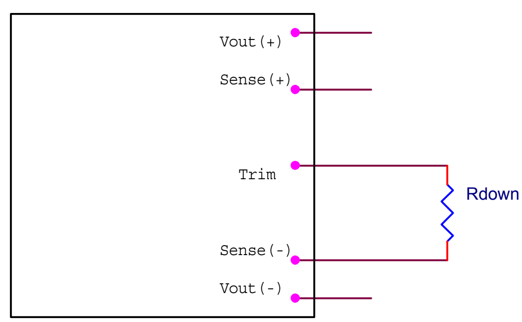
Remote On/Off: - The power modules have an internal remote on/off circuit. The user must supply an open-collector or compatible switch between the Vin(-) pin and the on/off pin. The maximum voltage generated by the power module at the on/off terminal is 15V. The maximum allowable leakage current of the switch is 50uA. The switch must be capable of maintaining a low signal Von/off < 1.2V while sinking 1mA.

The standard on/off logic is positive logic. The power module will turn on if terminal 2 is left open and will be off if terminal 2 is connected to terminal 4. An optional negative logic is available. The power module will turn on if terminal 2 is connected to terminal 4, and it will be off if terminal 2 is left open.



An On/Off Control Circuit

Output Voltage Adjustment: The output voltage of the power module may be adjusted by using an external resistor connected between the Vout trim terminal (pin 7) and either the Sense (+) or Sense (-) terminal. If the output voltage adjustment feature is not used, pin 7 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 Sense (-) pin may help avoid this.



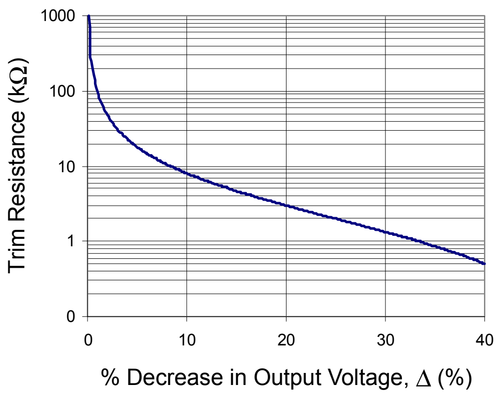
Circuit to decrease output voltage

With a resistor between the trim and Sense (-) terminals, the output voltage is adjusted down. To adjust the output voltage down a percentage of Vout (%Vo) from Vo,nom, the trim resistor should be chosen according to the following equation:

$$R_{down} = \left(\frac{100\%}{\Delta_{down}} - 2\right) \ \text{k}\Omega$$

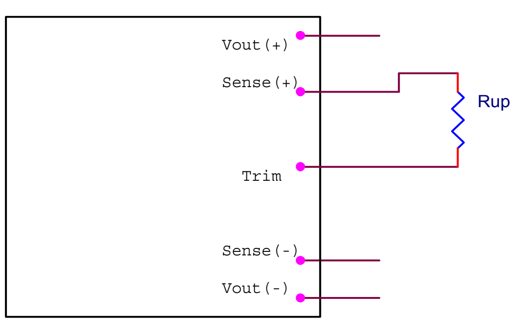
where

$$\Delta_{down} = \frac{V_{nom} - V_{desired}}{V_{nom}} \cdot 100\%$$



Trim down curve.

The current limit set point does not increase as the module is trimmed down, so the available output power is reduced.



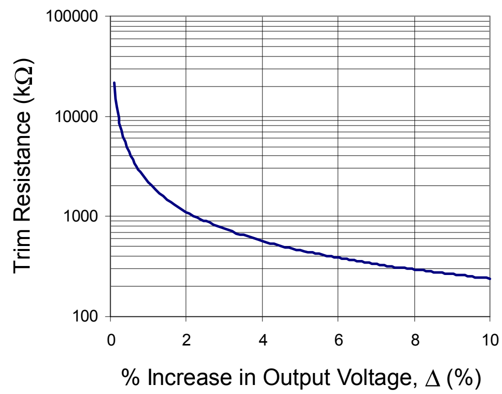
Circuit to increase output voltage

With a resistor between the trim and sense (+) terminals, the output voltage is adjusted up. To adjust the output voltage up a percentage of Vout (%Vo) from Vo,nom the trim resistor should be chosen according to the following equation:

$$R_{up} = \frac{\left[\frac{V_{nom}}{V_{ref}} - 2\right] \cdot (1 + \Delta_{up}) + 1}{\Delta_{up}} \ \text{k}\Omega$$

where

$$\Delta_{up} = \frac{V_{desired} - V_{nom}}{V_{nom}} \cdot 100\%$$ and



Trim up curve.

The value of Vref is 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.

As the output voltage is trimmed, the output over-voltage set point is not adjusted. Trimming the output voltage too high may cause the output over voltage protection circuit to be triggered.

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 and the Sense (-) terminal should be connected to the Vo(-) terminal.

The output voltage at the Vo(+) and Vo(-) terminals can be increased by either the

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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 must be decreased for the power module to remain below its maximum power rating

Synchronization: The power modules are capable of external synchronization from an independent time base, which is referenced to the secondary, or Sense(-). The synchronization frequency should be within the range of 310 kHz – 350 kHz with a pulse width of 50 nS and an amplitude of 4-5V.

Parallel Operation: Parallel operation serves two purposes: increase system power level and improve overall system reliability. For high power applications, several modules are usually in parallel to deliver higher current to the load. By sizing the power to $(N+1)P_{out}$ for an application that requires NP_{out}, redundancy is provided to the system. To ensure current sharing among modules the so-called “automatic master-slave control” is implemented. The unit that has the highest voltage set point issues the current reference signal to the sharing bus, and the remaining modules follow this current reference signal. If the master unit fails, the next highest voltage set unit module will automatically take control of the current sharing bus and become the new “master”.

The current sharing bus (pin y) carries a low-level voltage signal and links all the modules together, and therefore any noise contamination will cause poor current sharing or even malfunction. To ensure proper operation, one needs to pay special attention to the current sharing bus layout. It is suggested that the bus should be placed away from the noisy part of the circuit such as magnetic components. The trace length should be kept to minimum and outside of the module footprints if possible.

In the standard offering (-000), pin y is the current sharing pin which is referenced to the secondary side. An optional configuration is offered for modules with Vo,nom ≤ 12.0V. In this configuration the current sharing pin takes the place of the case pin (pin 3). Although the current sharing pin in this case is physically located with the primary circuitry, such as the input and on/off pins, the signal it carries is still referenced to the secondary side. In those applications where pin 3 is designated as the current sharing pin, enough spacing between the current sharing signal and the primary circuitry should be maintained, especially if basic insulation is required.

When multiple modules operate in parallel, the following is recommended:
1. The On/Off pins of all the modules should be connected together, and enabled at the same time.
2. An oring device, either a diode or MOSFET, should be present at the output of each module.
3. Each time a fault condition (e.g. output overload, output short circuit, output over-voltage, module over-heating, etc.) causes an output voltage loss, the On/Off control signal should be reset.

EMC Considerations: Innoveta power modules are designed for use in a wide variety of systems and applications. For assistance with designing for EMC compliance, please contact 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, a 200-1000uF input electrolytic capacitor should be present.

Reliability

The power modules are designed using Innoveta’s stringent design guidelines for component derating, product qualification, and design reviews. Early failures are screened out by both burn-in and an automated final test. The MTBF is calculated to be greater than 2M hours using the Telcordia TR-332 calculation method.

Improper handling or cleaning processes can adversely affect the appearance, testability, and reliability of the power modules. Contact

TDK Innoveta technical support for guidance regarding proper handling, cleaning, and soldering of TDK Innoveta's power modules.

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.

Safety Considerations:

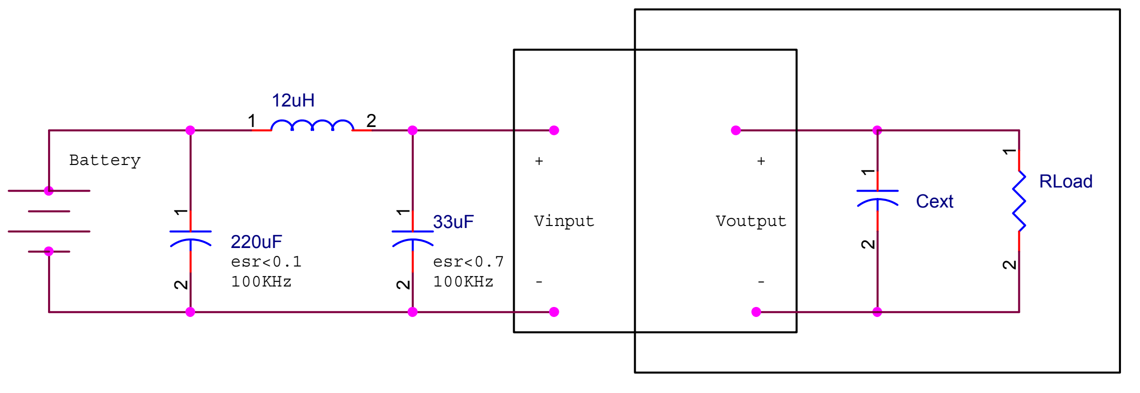
All TDK Innoveta products are certified to regulatory standards by an independent, Certified Administrative Agency laboratory. UL 1950, 3rd edition (US & Canada), and other global certifications are typically obtained for each product platform.

Various safety agency approvals are pending on the iHD product family. 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. The isolation is basic insulation. For applications requiring basic insulation, care must be taken to maintain minimum creepage and clearance distances when routing traces near the power module.

As part of the production process, the power modules are hi-pot tested from primary and secondary at a test voltage of 1500Vdc. The case pin is considered a primary pin for the purpose of hi-pot testing.

When the supply to the DC-DC converter is less than 60Vdc, the power module meets all of the requirements for SELV.
To preserve maximum flexibility, the power modules are not internally fused. An external input line normal blow fuse with a maximum value of 20A 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.

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 12uH 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.

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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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