

### FEATURES

- Wide 36-75V input range
- 12V output @ 21 Amps. max.
- Very high efficiency of 91%
- Operates to +110°C baseplate w/derating
- Conduction-cooled baseplate, no fans
- Industry-standard mounting and pinout
- Remote sense, trim and On/Off control
- Isolated to 2250Vdc (Basic insulation)
- Multiple I/O protection features
- UL/EN60950 safety approvals, CE mark
- Start up into pre-biased load

### DESCRIPTION

For “distributed architecture” power applications, DATEL’s UHP-12/21-D48 DC/DC converter offers a wide input range of 36-75 Volts DC, delivering up to 21 Amps with 12 Volts DC output. This DC/DC converter is an ideal precision intermediate bus power unit with tight regulation and 2250 Volt isolation. It is manufactured on a 2.3" x 2.4" open-frame package with industry-standard “half brick” pinout and mounting.

UHP converters use a interleaved forward, fixed-frequency topology with synchronous output rectification to achieve high efficiency. UHP-12/21-D48 can be operated using conduction cooling attached to a housing wall or system heat sink. No forced air-flow is needed to +110°C base-

### ORDERING GUIDE SUMMARY

Model	V <sub>OUT</sub> Range	I <sub>OUT</sub> Range	V <sub>IN</sub> Range	Ripple/Noise	Efficiency
UHP-12/21-D48	12V	0-21A	36-75V	125mVp-p	91%

### INPUT CHARACTERISTICS

Parameter	Typ. @ 25°C, full load	Notes
<b>Voltage Range</b>	36-75 Volts	48V nominal
<b>Current, full power</b>	5.77 Amps	V <sub>IN</sub> = 48V
<b>Undervoltage Shutdown</b>	33 Volts	
<b>Short Circuit Current</b>	20mA	V <sub>IN</sub> = 48V
<b>Remote On/Off Control</b>	0 to +V <sub>IN</sub>	Positive or negative logic

### OUTPUT CHARACTERISTICS

Parameter	Typ. @ 25°C, full load	Notes
<b>Voltage</b>	12 Volts ±10%	Trim range shown
<b>Current</b>	0 to 21 Amps	No minimum load
<b>Power Output</b>	255 Watts max.	Maximum baseplate = +110°C @ 255W
<b>Accuracy</b>	±1.25%	
<b>Ripple &amp; Noise</b>	125mVp-p	20MHz bandwidth
<b>Line and Load Regulation</b>	±0.05%/±0.25%	
<b>Overcurrent Protection</b>	30 Amps	With hiccup auto-restart
<b>Overtemperature Protection</b>	+125°C	
<b>Efficiency (minimum)</b>	90%	
<b>Efficiency (typical)</b>	91%	

### GENERAL SPECIFICATIONS

Parameter	Typ. @ 25°C, full load	Notes
<b>Dynamic Load Response</b>	150µsec	50-75-50% step to ±1.5% of final value
<b>Operating Temperature Range</b>	-40 to +110°C	With baseplate, see derating curve
<b>Operating Temperature Range</b>	-40 to +32°C	Without baseplate
<b>Safety</b>	UL/IEC/EN 60950	And CSA C22.2-No.60950

### MECHANICAL CHARACTERISTICS

With baseplate	2.30 x 2.40 x 0.502 inches (58.42 x 60.96 x 12.75 mm)
Without baseplate	2.30 x 2.40 x 0.452 inches (58.42 x 60.96 x 11.48 mm)

plate temperature. Multiple protection features avoid damage to outside equipment and to the converter itself. The converter will shut down on sustained input undervoltage, output overcurrent, output short circuit and overvoltage and thermal shutdown. Overload currents less than a short circuit limit the output current so that operation is not interrupted. Upon short circuit shutdown,

the converter will automatically attempt to restart (“hiccup” mode) when the overload is removed. The overall unit is designed to be as “lead-free” as practical in construction and attachment method (no lead added in assembly). Standard features also include Sense and Trim pins and On/Off Control.



PERFORMANCE SPECIFICATIONS AND ORDERING GUIDE <sup>①</sup>												
Model	Output						Input			Efficiency		Package (Case/ Pinout)
	V <sub>OUT</sub> (Volts)	I <sub>OUT</sub> (Amps)	R/N (mVp-p) <sup>②</sup>		Regulation (max.)		V <sub>IN</sub> Nom. (Volts)	Range (Volts)	I <sub>IN</sub> <sup>④</sup> (mA/A)	Min.	Typ.	
			Typ.	Max.	Line	Load <sup>③</sup>						
UHP-12/21-D48	12	21	125	175	±0.05%	±0.15%	48	36-75	195/5.77	90%	91%	C66, P17

- ① Typical at T<sub>A</sub> = +25°C under nominal line voltage and full-load conditions, unless noted.
- ② Ripple/Noise (R/N) is measured over a 20MHz bandwidth and input filter.
- ③ Regulation is tested no load to 100% load.
- ④ Nominal line voltage, no-load/full-load conditions.

### PART NUMBER STRUCTURE

**UHP - 12 / 21 - D48 N B Lx - C**

**Optional Functions**

**Unipolar High-Power**

**Nominal Output Voltage:**  
12 Volts

**Maximum Output Current:**  
21 Amps

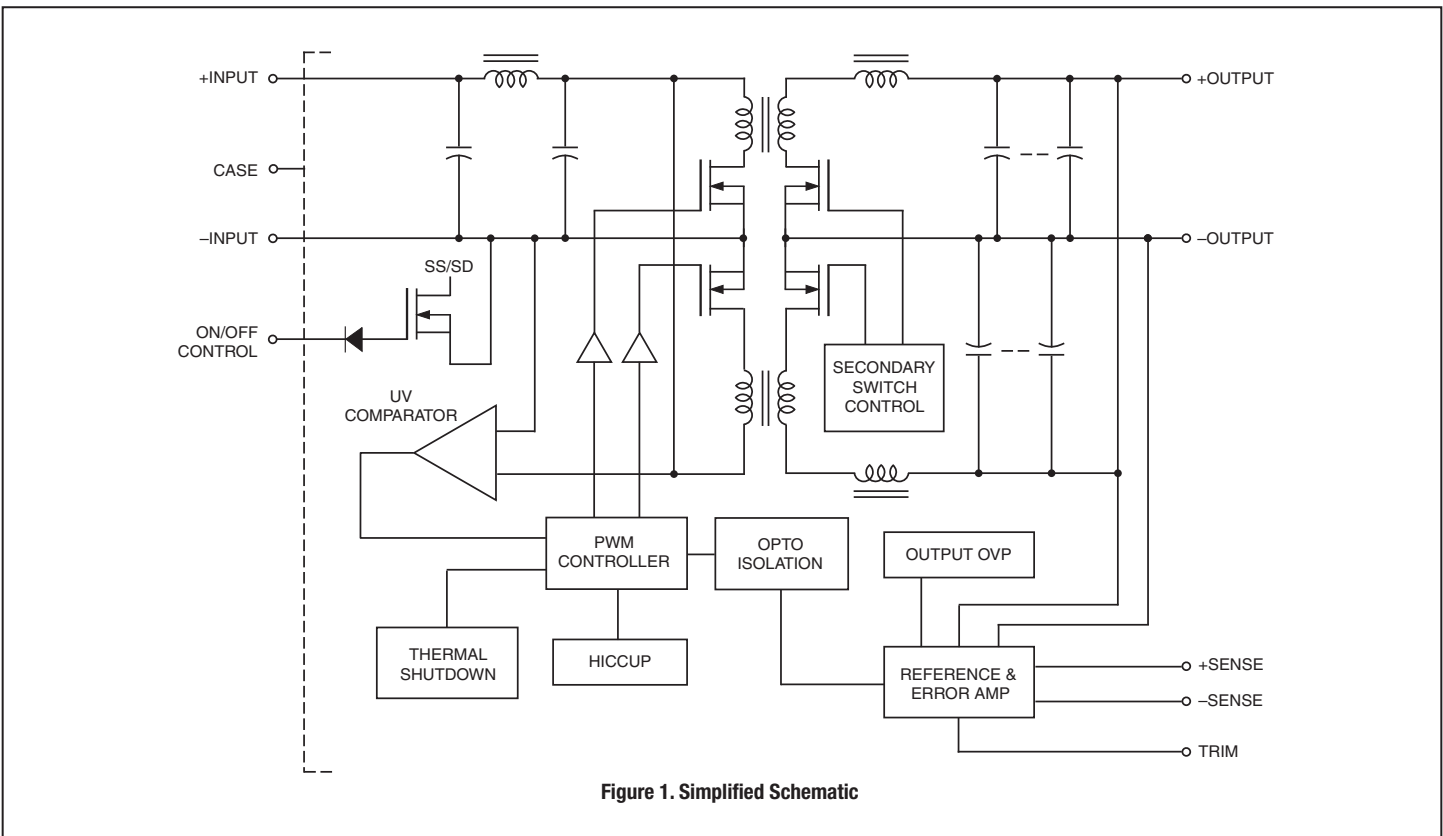
**On/Off Control Polarity:**  
P = Positive  
N = Negative

**Input Voltage Range:**  
D48 = 36-75 Volts (48V nominal)

**Baseplate:**  
Blank = not installed  
B = Installed

**Alternate Pin Length:**  
Blank = Standard pin length  
L1 = 0.110 in. (2.79mm) ±0.010  
L2 = 0.145 in. (3.68mm) ±0.010

\* Contact Murata Power Solutions (DATEL) for availability



### Performance/Functional Specifications

Typical @ TA = +25°C under nominal line voltage, full-load conditions, unless noted. <sup>(1)</sup>

Input	
<b>Input Voltage Range</b>	See Ordering Guide
<b>Start-Up Threshold</b>	33/35 Volts (min./max.)
<b>Undervoltage Shutdown</b>	32/34 Volts (min./max.)
<b>Voltage Transients</b> (100msec, no damage)	+100 Volts max.
<b>Overvoltage Shutdown</b>	None <sup>(7)</sup>
<b>Reflected (Back) Ripple Current</b> <sup>(2)</sup>	15mA <sub>p-p</sub>
<b>Input Current:</b>	
Full Load Conditions	See Ordering Guide
Inrush Transient	0.5A <sup>2</sup> sec
Output Short Circuit	20mA
No Load	195mA
Low Line (V <sub>IN</sub> = V <sub>MIN</sub> )	7.65 Amps
Standby Mode (Off, UV, OT, OC shutdown)	8mA
<b>Internal Input Filter</b>	Pi-type
<b>Recommended External Fuse</b>	15 Amps slow blow
<b>Reverse Polarity Protection</b>	See fuse information
<b>Remote On/Off Control:</b> <sup>(5)</sup>	
Positive Logic ("P" model suffix)	ON = open or +3.5V min. to +V <sub>IN</sub> max. OFF = -0.5V min. to +0.8V max.
Negative Logic ("N" model suffix)	ON = ground pin to +0.8V max. OFF = +3.5V min. to +V <sub>IN</sub> max.
Output	
<b>Total Output Power</b>	255 Watts max.
<b>Voltage Output Range</b>	See Ordering Guide
<b>Voltage Output Accuracy</b>	±1.25 % of V <sub>NOMINAL</sub>
<b>Extreme Accuracy</b>	±3 % max. of V <sub>NOMINAL</sub> <sup>(15)</sup>
<b>Overvoltage Protection</b> <sup>(14)</sup> Method	+14.5 Volts Magnetic feedback and comparator
<b>Voltage Adjustment Range</b> <sup>(12)</sup>	±10% of V <sub>NOMINAL</sub>
<b>Temperature Coefficient</b>	±0.02% of V <sub>OUT</sub> range per °C
<b>Minimum Loading</b>	No minimum load
<b>Remote Sense Compensation</b>	+5% max.
<b>Ripple/Noise</b> (20 MHz bandwidth)	See Ordering Guide <sup>(8)</sup>
<b>Line/Load Regulation</b>	See Ordering Guide and note <sup>(10)</sup>
<b>Efficiency</b>	See Ordering Guide
<b>Maximum Capacitive Loading</b>	3300µF (Low ESR <0.02Ω max.)
<b>Isolation Voltage:</b>	
Input to Output	2250Vdc min.
Input to Baseplate	1500Vdc min.
Baseplate to Output	750Vdc min.
<b>Isolation Resistance</b>	100MΩ
<b>Isolation Capacitance</b>	2000 pF
<b>Isolation Safety Rating</b>	Basic insulation
<b>Current Limit Inception</b> (98% of V <sub>OUT</sub> )	30 Amps, cold condition 28 Amps, after warmup
<b>Short Circuit</b> <sup>(6)</sup>	
Protection Method	Current limiting with hiccup autorestart
Short Circuit Current	1 Amp
Short Circuit Duration (no damage)	Continuous, output shorted to ground

### Dynamic Characteristics

<b>Dynamic Load Response</b> (50-75-50%step)	150µsec to ±1.25% of final value
<b>Load Step Peak Deviation</b>	±700mV
<b>Start-Up Time</b>	280msec for V <sub>OUT</sub> = nominal
<b>Remote On/Off to V<sub>OUT</sub> Regulated</b>	2msec
<b>Switching Frequency</b>	290kHz

### Environmental

<b>Calculated MTBF</b> <sup>(4)</sup>	945,162 Hours
<b>Operating Temperature Range</b> (Ambient, with unmounted baseplate):	
No derating, 400 lfm	-40 to +32°C <sup>(9)</sup>
With derating	See Derating Curves
<b>Operating Temperature with Baseplate</b> (Mounted to heat sink)	
(No derating required) <sup>(3)</sup> <sup>(13)</sup>	-40 to +110°C max.
<b>Storage Temperature Range</b>	-55 to +125°C
<b>Thermal Protection/Shutdown</b> <sup>(13)</sup>	+125°C (hotspot)
<b>Density Altitude</b>	0 to 10,000 feet
<b>Relative Humidity</b>	10% to 90%, non-condensing

### Physical

<b>Outline Dimensions</b>	See Mechanical Specifications
<b>Baseplate Material</b>	Aluminum
<b>Pin Material</b>	Solder-coated brass
<b>Weight</b>	3.3 ounces (94 grams)
<b>Electromagnetic Interference</b> Conducted and radiated	FCC part 15, class B, EN55022 (external filter may be required)
<b>Safety</b>	UL/cUL 60950 CSA-C22.2 No.234 IEC/EN 60950
<b>Flammability</b>	ULV94-0

### Absolute Maximum Ratings

<b>Input Voltage</b>	
Continuous	to +75V
Transient (100 msec max.)	to +100V
<b>On/Off Control</b>	-0.3 V min to +V <sub>IN</sub> max.
<b>Input Reverse Polarity Protection</b>	See Fuse section <sup>(11)</sup>
<b>Output Overvoltage</b>	V <sub>OUT</sub> +20% max.
<b>Output Current</b> <sup>(7)</sup>	Current-limited. Devices can withstand sustained short circuit without damage.
<b>Storage Temperature</b>	-55 to +125°C
<b>Lead Temperature</b> (soldering 10 sec. max.)	+280°C

These are stress ratings. Exposure of devices to any of these conditions may adversely affect long-term reliability. Proper operation under conditions other than those listed in the Performance/Functional Specifications Table is not implied, nor recommended.

### Performance/Functional Specification Notes:

<sup>(1)</sup> The UHP-12/21-D48 is tested and specified with natural convection airflow, external 1 || 10µF ceramic/tantalum output capacitors and a 22µF external input capacitor. All capacitors are low ESR types. These capacitors are necessary to accommodate our test equipment and may not be required to achieve specified performance in your applications. All models are stable and regulate within spec under no-load conditions.

General conditions for Specifications are +25°C, V<sub>IN</sub> = nominal, V<sub>OUT</sub> = nominal, full load.

<sup>(2)</sup> Input Ripple Current is tested and specified over a 5Hz to 20MHz bandwidth. Input filtering is C<sub>IN</sub> = 33µF tantalum, C<sub>BUS</sub> = 220µF electrolytic, L<sub>BUS</sub> = 12µH.

### Performance/Functional Specification Notes:

- (3) Note that Maximum Power Derating curves indicate an average current at nominal input voltage. At higher temperatures and/or lower airflow, the DC/DC converter will tolerate brief full current outputs if the total RMS current over time does not exceed the Derating curve.
- (4) Mean Time Before Failure is calculated using the Telcordia (Belcore) SR-332 Method 1, Case 3, ground fixed conditions, operating temperature = 55°C, full output load, natural air convection.
- (5) The On/Off Control may be driven with external logic or by applying appropriate external voltages which are referenced to Input Common. The On/Off Control Input should use either an open collector/open drain transistor or logic gate which does not exceed +V<sub>IN</sub> max.
- (6) Short circuit shutdown begins when the output voltage degrades approximately 2% from the selected setting. Remove overload for recovery.
- (7) Input overvoltage shutdown is explicitly not included to improve system reliability in datacom and telecom applications. These requirements attempt continued operation despite significant input overvoltage.
- (8) Output noise may be further reduced by adding an external filter. See I/O Filtering and Noise Reduction.
- (9) Models are fully operational and meet published specifications, including "cold start" at -40°C.
- (10) Regulation specifications describe the deviation as the line input voltage or output load current is varied from a nominal midpoint value to either extreme.
- (11) If the input voltage is reversed, a normally back-biased bulk substrate diode will become forward biased and draw current. An external fuse is recommended to avoid damage from reverse input current.
- (12) Do not exceed maximum power specifications when adjusting the output trim.
- (13) Note that the converter may operate up to +110°C with the baseplate installed. However, thermal self-protection occurs near +125°C on the circuit hotspot. And there is a thermal gradient between the baseplate and the hotspot. Therefore, +110°C maximum baseplate temperature is recommended to avoid thermal shutdown.
- (14) If the output exceeds the Overvoltage specification, the output will shut down in auto recovery mode.
- (15) Extreme accuracy includes all combinations of temperature coefficient and line/load regulation.

### TECHNICAL NOTES

#### Input Fusing

Certain applications and/or safety agencies may require the installation of fuses at the inputs of power conversion components. Fuses should also be used if the possibility of sustained, non-current-limited, input-voltage polarity reversals exists. For DATEL UHP Series DC/DC Converters, we recommend the use of slow-blow type fuses, installed in the ungrounded input supply line, with values no greater than the following.

Output	Fuse Value
12 V <sub>OUT</sub>	15 Amp

All relevant national and international safety standards and regulations must be observed by the installer. For system safety agency approvals, the converters must be installed in compliance with the requirements of the end-use safety standard, i.e. IEC/EN/UL60950.

#### Input Undervoltage Shutdown and Start-Up Threshold

Under normal start-up conditions, devices will not begin to regulate properly until the ramping-up input voltage exceeds the Start-Up Threshold Voltage. Once operating, devices will not turn off until the input voltage drops below the Undervoltage Shutdown limit. Subsequent re-start will not occur until the input is brought back up to the Start-Up Threshold. This built in hysteresis prevents any unstable on/off situations from occurring at a single input voltage.

#### Start-Up Time

The V<sub>IN</sub> to V<sub>OUT</sub> Start-Up Time is the interval of time between the point at which the ramping input voltage crosses the Start-Up Threshold and the fully loaded output voltage enters and remains within 90% of V<sub>OUT</sub>. Actual measured times will vary with input source impedance, external input capacitance, and the slew rate and final value of the input voltage as it appears at the converter. The UHP Series implements a soft start circuit that limits the duty cycle of its PWM controller at power up, thereby limiting the input inrush current.

The On/Off Control to V<sub>OUT</sub> start-up time assumes the converter has its nominal input voltage applied but is turned off via the On/Off Control pin. The specification defines the interval between the point at which the converter is turned on (released) and the fully loaded output voltage enters and remains within its specified accuracy band.

Similar to the V<sub>IN</sub> to V<sub>OUT</sub> start-up, the On/Off Control to V<sub>OUT</sub> start-up time is also governed by the internal soft start circuitry and external load capacitance. The difference in start up time from V<sub>IN</sub> to V<sub>OUT</sub> and from On/Off Control to V<sub>OUT</sub> is therefore insignificant.

#### Input Overvoltage Shutdown

The UHP Series does not feature input overvoltage shutdown. The converters do withstand and fully operate during input transients to 100V for 100msec without interruption; consequently, this function has been disabled.

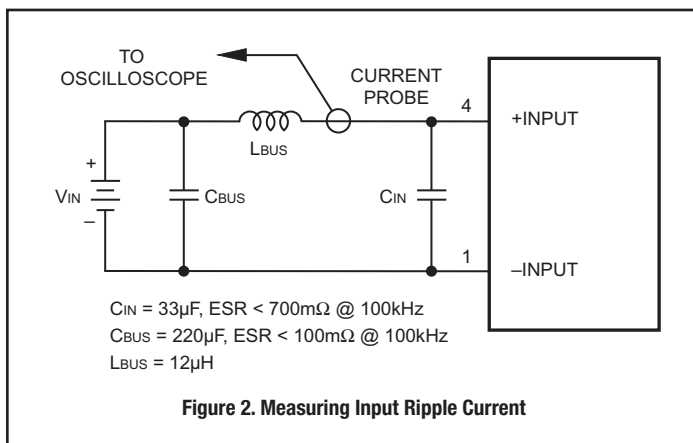
#### Input Source Impedance

The input of UHP converters must be driven from a low ac-impedance source. The DC/DC's performance and stability can be compromised by the use of highly inductive source impedances. The input circuit shown in Figure 2 is a practical solution that can be used to minimize the effects of inductance in the input traces. For optimum performance, components should be mounted as close as possible to the DC/DC converter.

**I/O Filtering, Input Ripple Current, and Output Noise**

All models in the UHP Series are tested/specified for input reflected ripple current and output noise using the specified external input/output components/circuits and layout as shown in the following two figures.

External input capacitors ( $C_{IN}$  in Figure 2) serve primarily as energy-storage elements, minimizing line voltage variations caused by transient IR drops in conductors from backplane to the DC/DC. Input caps should be selected for bulk capacitance (at appropriate frequencies), low ESR, and high rms-ripple-current ratings. The switching nature of DC/DC converters requires that dc voltage sources have low ac impedance as highly inductive source impedance can affect system stability. In Figure 2,  $C_{BUS}$  and  $L_{BUS}$  simulate a typical dc voltage bus. Your specific system configuration may necessitate additional considerations.



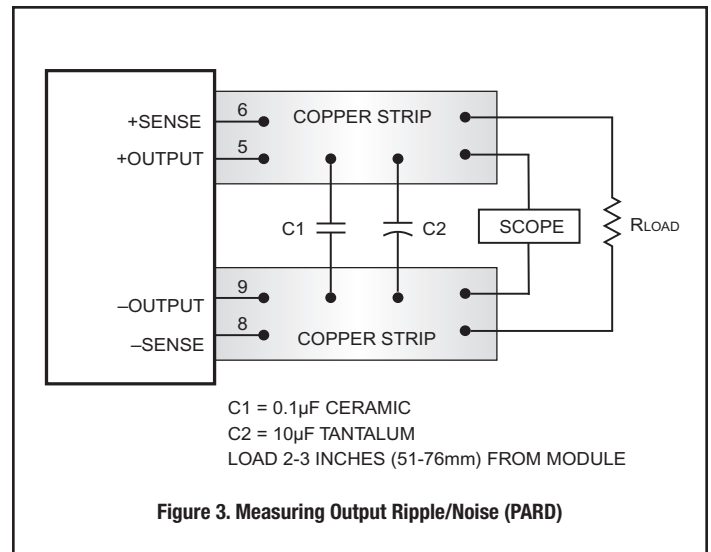
In critical applications, output ripple/noise (also referred to as periodic and random deviations or PARD) may be reduced below specified limits using filtering techniques, the simplest of which is the installation of additional external output capacitors. They function as true filter elements and should be selected for bulk capacitance, low ESR and appropriate frequency response. All external capacitors should have appropriate voltage ratings and be located as close to the converter as possible. Temperature variations for all relevant parameters should also be taken carefully into consideration.

The most effective combination of external I/O capacitors will be a function of line voltage and source impedance, as well as particular load and layout conditions. Our Applications Engineers can recommend potential solutions and discuss the possibility of our modifying a given device's internal filtering to meet your specific requirements. Contact our Applications Engineering Group for additional details.

In Figure 3, the two copper strips simulate real-world PCB impedances between the power supply and its load. In order to minimize measurement errors, scope measurements should be made using BNC connectors, or the probe ground should be as short as possible (i.e. less than 1/2 inch) and soldered directly to the fixture.

**Floating Outputs**

Since these are isolated DC/DC converters, their outputs are "floating" with respect to their input. Designers will normally use the -Output (pin 9) as the ground/return of the load circuit. You can however, use the +Output (pin 5) as ground/return to effectively reverse the output polarity.



**Minimum Output Loading Requirements**

UHP converters employ a synchronous-rectifier design topology and all models regulate within spec and are stable under no-load to full load conditions. Operation under no-load conditions however might slightly increase the output ripple and noise.

**Thermal Shutdown**

The UHP converters are equipped with thermal-shutdown circuitry. If environmental conditions cause the temperature of the DC/DC converter to rise above the designed operating temperature, a precision temperature sensor will power down the unit. When the internal temperature decreases below the threshold of the temperature sensor, the unit will self start. See Performance/Functional Specifications.

**Output Overvoltage Protection**

The UHP output voltage is monitored for an overvoltage condition using a comparator. The signal is optically coupled to the primary side and if the output voltage rises to a level which could be damaging to the load, the sensing circuitry will power down the PWM controller causing the output voltage to decrease. Following a time-out period the PWM will restart, causing the output voltage to ramp to its appropriate value. If the fault condition persists, and the output voltage again climbs to excessive levels, the overvoltage circuitry will initiate another shutdown cycle. This on/off cycling is referred to as "hiccup" mode.

**Current Limiting**

As soon as the output current increases to approximately 120% of its rated value, the DC/DC converter will go into a current-limiting mode. In this condition, the output voltage will decrease proportionately with increases in output current, thereby maintaining somewhat constant power dissipation. This is commonly referred to as power limiting. Current limit inception is defined as the point at which the full-power output voltage falls below the specified tolerance. See Performance/Functional Specifications. If the load current, being drawn from the converter, is significant enough, the unit will go into a short circuit condition as described below.

**Short Circuit Condition**

When a converter is in current-limit mode, the output voltage will drop as the output current demand increases. If the output voltage drops too low, the magnetically coupled voltage used to develop primary side voltages will also drop, thereby shutting down the PWM controller. Following a time-out period, the PWM will restart causing the output voltage to begin ramping to their appropriate value. If the short-circuit condition persists, another shutdown cycle will be initiated. This on/off cycling is referred to as "hiccup" mode. The hiccup cycling reduces the average output current, thereby preventing internal temperatures from rising to excessive levels. The UHP Series is capable of enduring an indefinite short circuit output condition.

**Features and Options**

**Remote Sense**

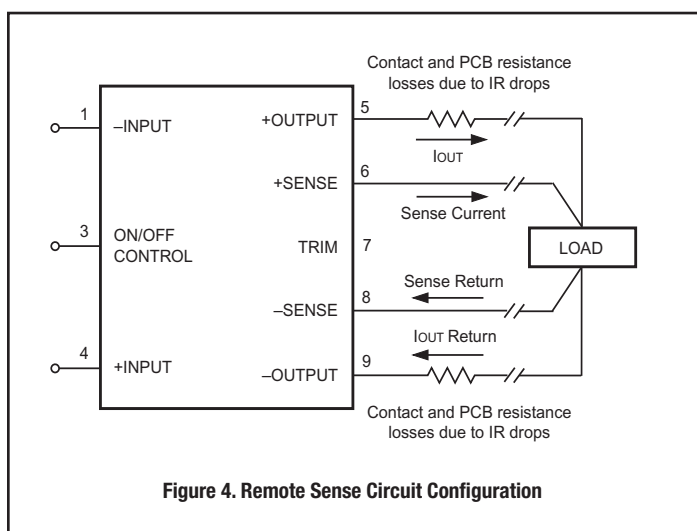
Note: The Sense and V<sub>OUT</sub> lines are internally connected through resistors (≈10Ω). Nevertheless, if the sense function is not used for remote regulation the user should connect the +Sense to +V<sub>OUT</sub> and -Sense to -V<sub>OUT</sub> at the DC/DC converter pins.

UHP Series converters employ a sense feature to provide point of use regulation, thereby overcoming moderate IR drops in pcb conductors or cabling. The remote sense lines carry very little current and therefore require minimal cross-sectional-area conductors. The sense lines, which are capacitively coupled to their respective output lines, are used by the feedback control-loop to regulate the output. As such, they are not low impedance points and must be treated with care in layouts and cabling. Sense lines on a pcb should be run adjacent to dc signals, preferably ground. In cables and discrete wiring applications, twisted pair or other techniques should be implemented.

UHP Series converters will compensate for drops between the output voltage at the DC/DC and the sense voltage at the DC/DC provided that:

$$[V_{OUT (+)} - V_{OUT (-)}] - [Sense(+) - Sense (-)] \leq 5\% V_{OUT}$$

$$(\leq 10\% V_{OUT} \text{ for } 3.3V \text{ models})$$



**Figure 4. Remote Sense Circuit Configuration**

Output overvoltage protection is monitored at the output voltage pin, not the Sense pin. Therefore, excessive voltage differences between V<sub>OUT</sub> and Sense in conjunction with trim adjustment of the output voltage can cause the overvoltage protection circuitry to activate (see Performance Specifications for overvoltage limits). Power derating is based on maximum output current and voltage at the converter's output pins. Use of trim and sense functions can cause output voltages to increase, thereby increasing output power beyond the converter's specified rating, or cause output voltages to climb into the output overvoltage region. Therefore, the designer must ensure:

$$(V_{OUT \text{ at pins}}) \times (I_{OUT}) \leq \text{rated output power}$$

**On/Off Control Function**

The input-side remote On/Off Control is an external input signal available in either positive ("P" suffix) or negative polarity ("N" suffix). Normally this input is controlled by an external transistor or relay. However, with simple external circuits, it may also be selected by logic outputs.

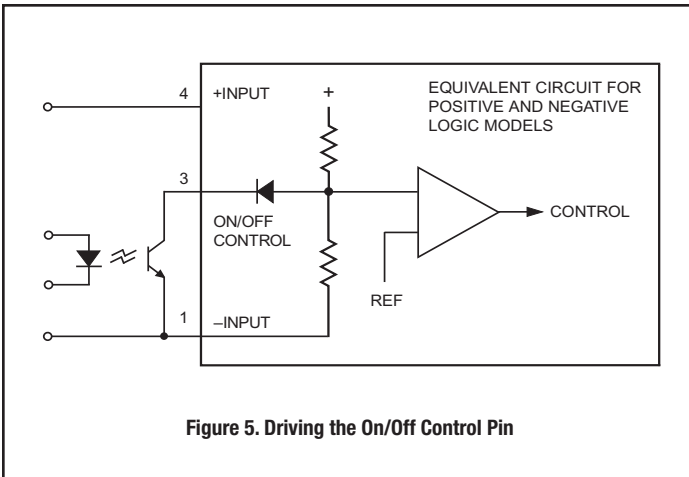
For the positive polarity, the default operation is to leave this pin open (unconnected). This results in the converter always on whenever appropriate input power is applied. Negative polarity models require the On/Off input to be grounded to the -INPUT terminal or brought low to turn the converter on.

Both models include an internal pullup source on this pin. For positive polarity, grounding the input will turn it off (zero output) and raising the input above approximately +3.5 Volts or an open pin will turn it on (or driving a control transistor into cutoff).

For negative polarity, ground the input to -INPUT to turn on the converter. An open pin (or if the input is raised above +3.5 Volts) turns it off. For both polarities, do not raise the On/Off Control above +V<sub>IN</sub> relative to the -INPUT terminal. All control inputs must be referred to the -INPUT terminal.

Dynamic control of the On/Off Control should be capable of sinking the appropriate current (less than 1mA) and not overdrive the input above +V<sub>IN</sub>. Do not apply external voltage to the On/Off Control when no input power is present. Always wait for input power to stabilize before activating the On/Off Control. Be aware that several milliseconds (see specifications) are required between activation of the control and when output power is stabilized and in regulation.

Special Note: Although a small internal protective diode is included in series with the On/Off, do not directly use the 48V +INPUT line as an external pullup source for the external On/Off control. The On/Off input must be held to +V<sub>IN</sub> maximum.



**Figure 5. Driving the On/Off Control Pin**

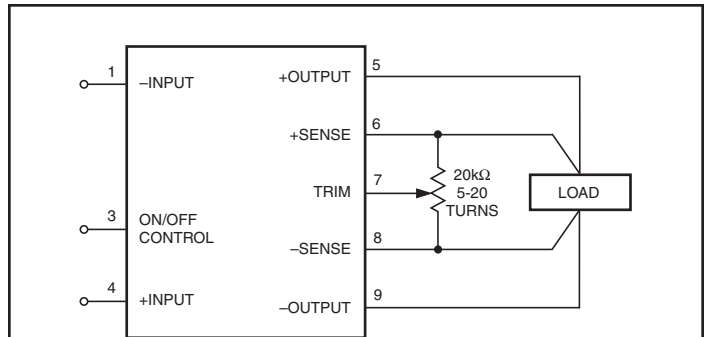
**Trimming Output Voltage**

UHP converters have a trim capability (pin 7) that allows users to adjust the output voltage within the specified range. Adjustments to the output voltages can be accomplished via a trim pot (Figure 6) or a single fixed resistor as shown in Figures 7 and 8. A single fixed resistor can increase or decrease the output voltage depending on its connection. The resistor should be located close to the converter and have a TCR less than 100ppm/°C to minimize sensitivity to changes in temperature. If the trim function is not used, leave the trim pin floating.

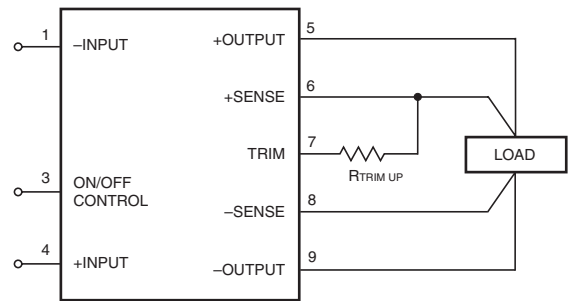
A single resistor connected from the Trim (pin 7) to the +Sense (pin 6), will increase the output voltage (Figure 7). A resistor connected from the Trim (pin 9) to the -Sense (pin 8), will decrease the output voltage (Figure 8).

Trim adjustments greater than the specified range can have an adverse affect on the converter's performance and are not recommended. Excessive voltage differences between  $V_{OUT}$  and Sense, in conjunction with trim adjustment of the output voltage, can cause the overvoltage protection circuitry to activate (see Performance Specifications for overvoltage limits). Power derating is based on maximum output current and voltage at the converter's output pins. Use of trim and sense functions can cause output voltages to increase, thereby increasing output power beyond the converter's specified rating or cause output voltages to climb into the output overvoltage region. Therefore:

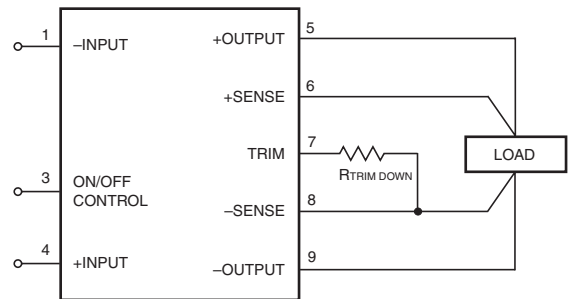
$$(V_{OUT} \text{ at pins}) \times (I_{OUT}) = \leq \text{rated output power}$$



**Figure 6. Trim Connections Using A Trim Pot**



**Figure 7. Trim Connections To Increase Output Voltages Using Fixed Resistors**



**Figure 8. Trim Connections To Decrease Output Voltages Using Fixed Resistors**

**Trim Equations**

$$R_{TUP} (k\Omega) = \frac{V_o(100 + \Delta\%)}{1.225 \times \Delta\%} - \frac{100 + 2 \times \Delta\%}{\Delta\%} \quad R_{TDOWN} (k\Omega) = \frac{100}{\Delta\%} - 2$$

where  $\Delta\%$  is the desired change of the output voltage in percent relative to  $V_{NOMINAL}$ . Or,

$$\pm\Delta\% = \frac{V_{OUT} - V_{NOM}}{V_{NOM}} \times 100$$

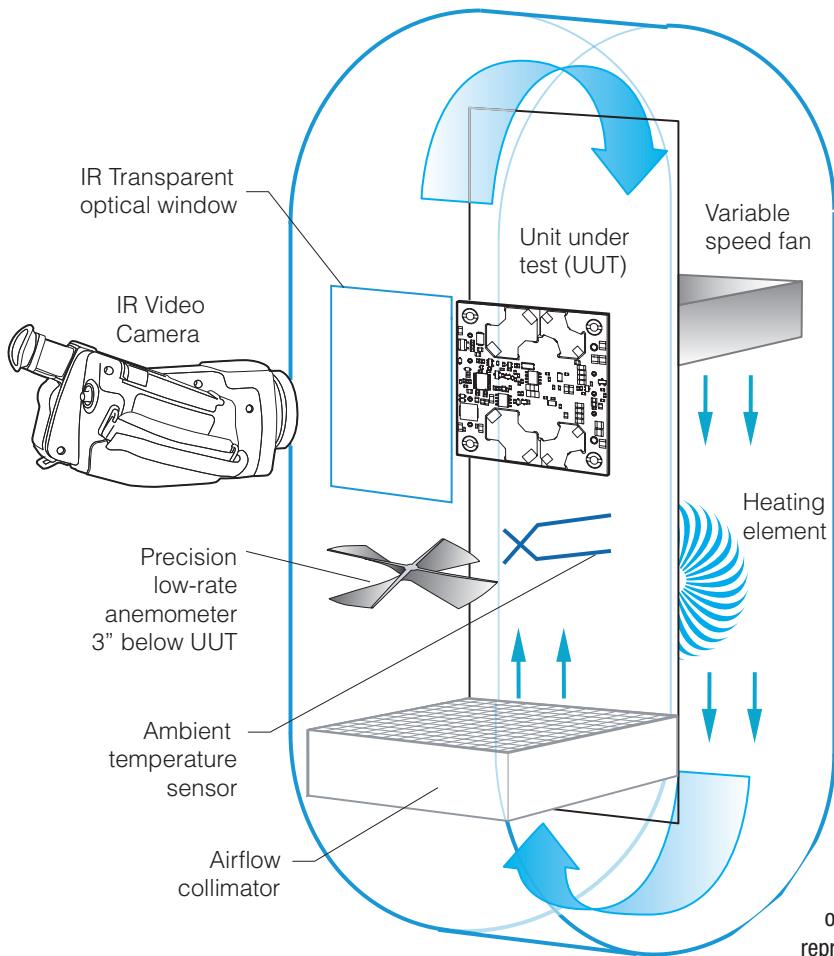


Figure 9. Vertical Wind Tunnel



Figure 10. Thermal Image, Bottom View  
(VIN = 48V, TA = +25°C, IOUT = 14.1 Amps, natural convection, unmounted)

**Vertical Wind Tunnel**

DATEL employs a custom-designed enclosed vertical wind tunnel, infrared video camera system and test instrumentation for accurate airflow and heat dissipation analysis of power products. The system includes a precision low flow-rate anemometer, variable speed fan, power supply input and load controls, temperature gauges and adjustable heating element.

The IR camera can watch thermal characteristics of the Unit Under Test (UUT) with both dynamic loads and static steady-state conditions. A special optical port is used which is transparent to infrared wavelengths. The computer files from the IR camera can be studied for later analysis.

Both pinned and surface mount converters are soldered down to a host carrier board for realistic heat absorption and spreading. Both longitudinal and transverse airflow studies are possible by rotation of this carrier board since there are often significant differences in the heat dissipation in the two airflow directions. The combination of both adjustable airflow, adjustable ambient heat and adjustable Input/Output currents and voltages mean that a very wide range of measurement conditions can be studied.

Whereas some competitors use only thermocouples or RTDs for heat dissipation studies, IR cameras offer superior advantages:

1. Thermocouples obviously measure only one point each. Adding more points is a burden to supply more low-level TC electronics. The investigator has to guess which components to measure and where to measure. In contrast, the IR camera measures ALL points simultaneously on the UUT. More important, TC wires can conduct away a significant amount of heat, giving false readings of peak temperatures. Many wires mean more lost heat and is not representative of real-world applications.

Securely attaching the TC wires with thermal compound is time-consuming and not totally repeatable unit to unit.

2. The IR camera shows areas which were not previously suspected of overheating. While the usual method is to concentrate on high power inductors and semiconductors, the IR camera has unwittingly caught overheating capacitors and other small components.
3. To compensate for the slightly greater accuracy of TCs or RTDs, DATEL sometimes uses BOTH the IR camera and TCs to compare readings.
4. The IR camera is excellent at showing heat flow. It has identified higher temperature ground planes which need area and/or thickness increase. It has also pointed out overheating components “downwind” from hot spots, depending on airflow direction.

The airflow collimator mixes the heat from the heating element to make uniform temperature distribution. The collimator also reduces the amount of turbulence adjacent to the UUT by restoring laminar airflow. Such turbulence can change the effective heat transfer characteristics and give false readings. Excess turbulence removes more heat from some surfaces and less heat from others, possibly causing uneven overheating.

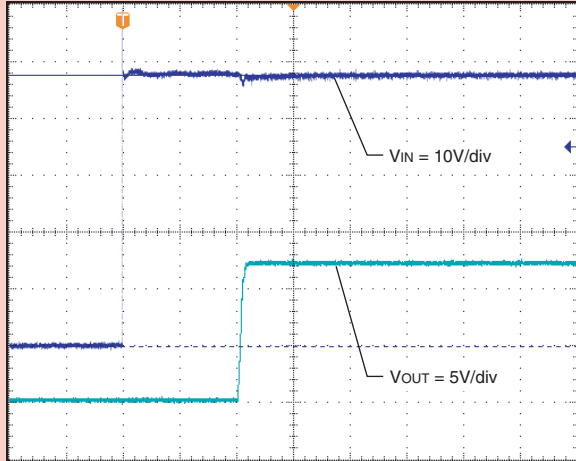
Both sides of the UUT are studied since there are different thermal gradients on each side. The adjustable heating element and fan, built-in temperature gauges and no-contact IR camera mean that power supplies are tested in real-world conditions.



**TYPICAL PERFORMANCE CURVES**

**Start-Up from Power On**

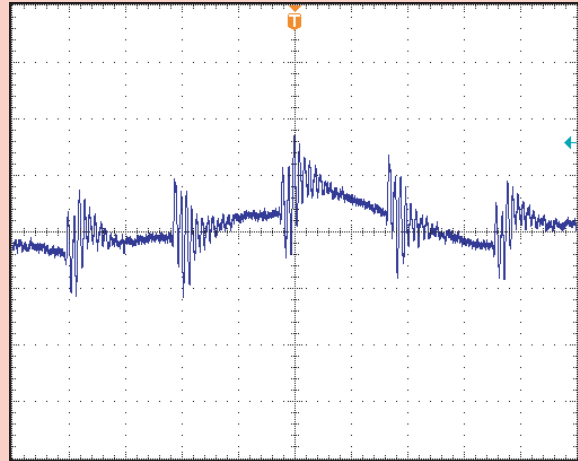
(VIN = 48V, IOUT = 21A, COUT = 3300μF)



10msec/div

**Output Ripple and Noise (PARD)**

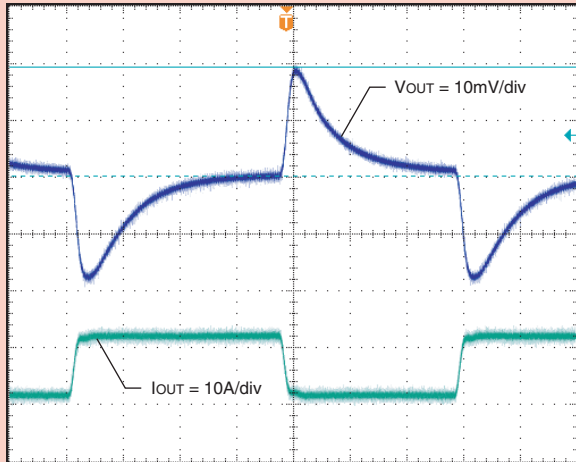
(VIN = 48V, IOUT = 21A, COUT = 10μF || 1μF)



20mV, 1μsec/div, 20MHz BW

**Output Load Step Transient Response**

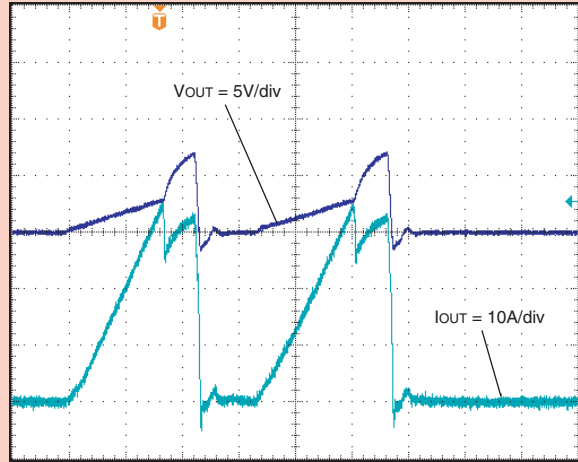
(VIN = 48V, COUT = 10μF || 1μF, 50-100-50% Load Step)



100μsec/div

**Output Current Limit (hiccup)**

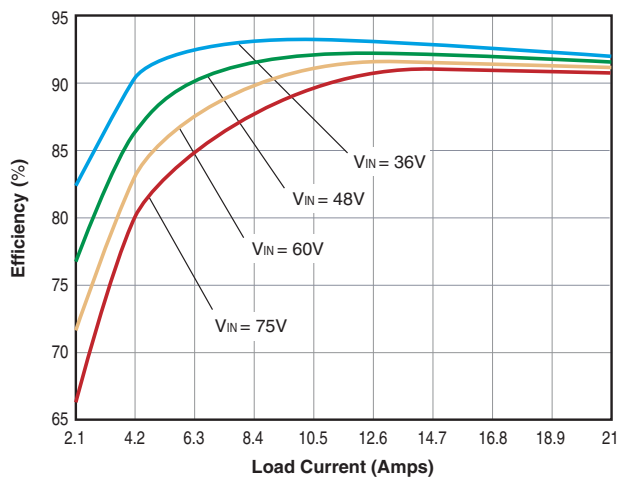
(VIN = 48V, +25°C)



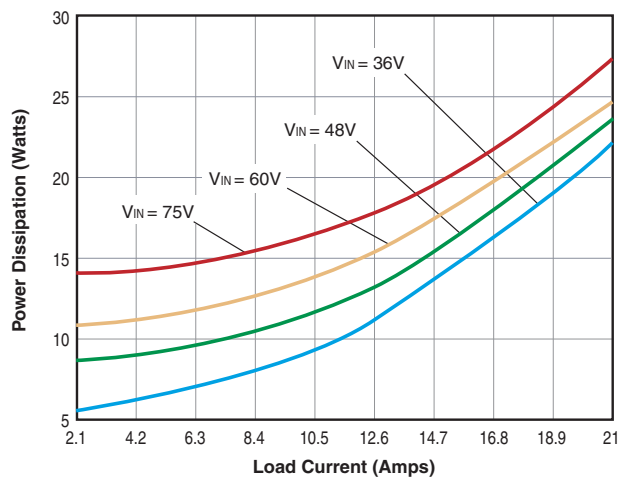
400μsec/div

## TYPICAL PERFORMANCE CURVES

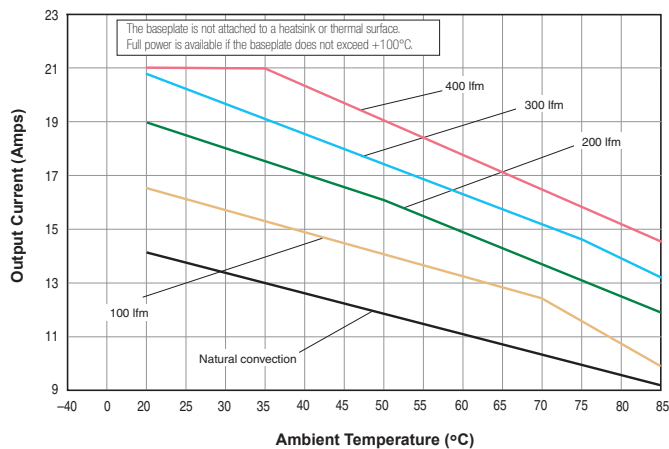
**UHP-12/21-D48 Efficiency vs. Line Voltage and Load Current @ 25°C**



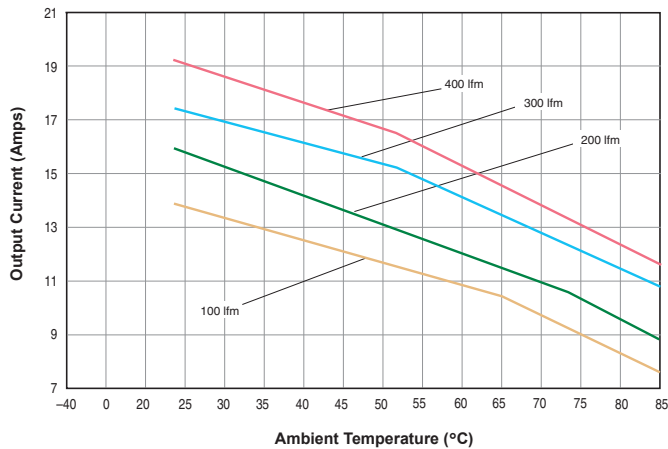
**UHP-12/21-D48 Power Dissipation vs. Line Voltage and Load Current**



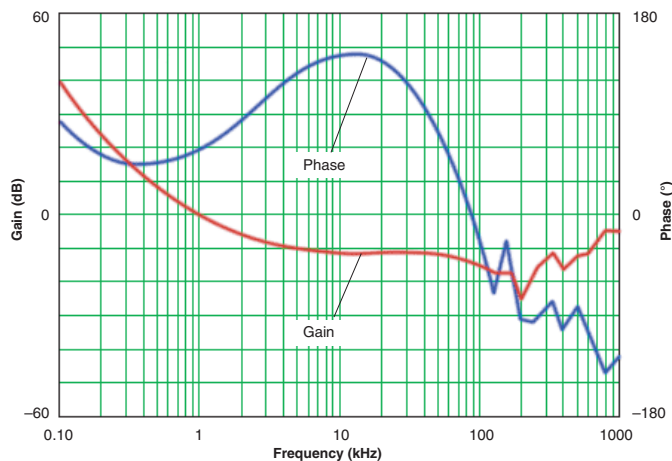
**UHP-12/21-D48 Maximum Output Current Temperature Derating**  
VIN = 48V (With baseplate. Air flow direction from input pins to output pins.)



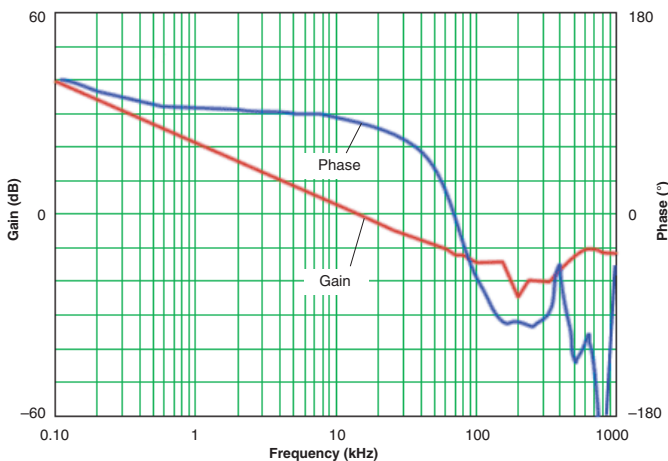
**UHP-12/21-D48 Maximum Output Current Temperature Derating**  
VIN = 48V (No baseplate. Air flow direction from input pins to output pins.)



**UHP-12/21-D48N Bode Plot Analysis @+25°C**  
(VIN = 48V, IOUT = 21A, TA = +25°C, COUT = 10µF || 1µF || 3300µF)

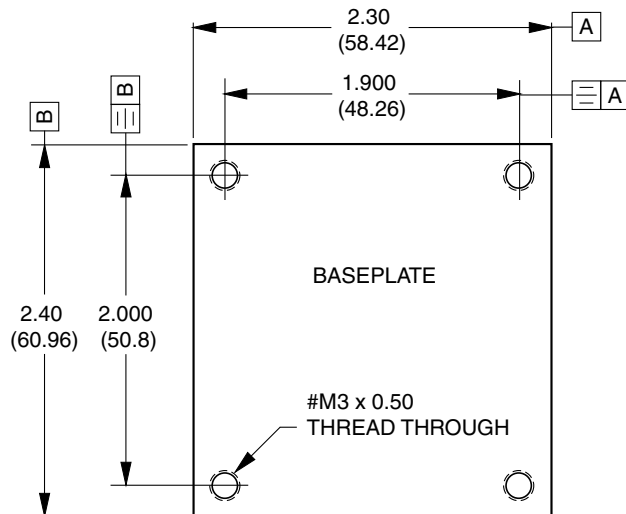


**UHP-12/21-D48N Bode Plot Analysis @+25°C**  
(VIN = 48V, IOUT = 21A, TA = +25°C, COUT = 10µF || 1µF)

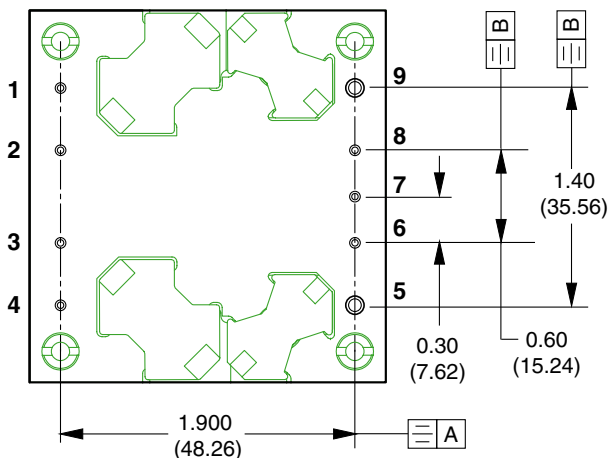
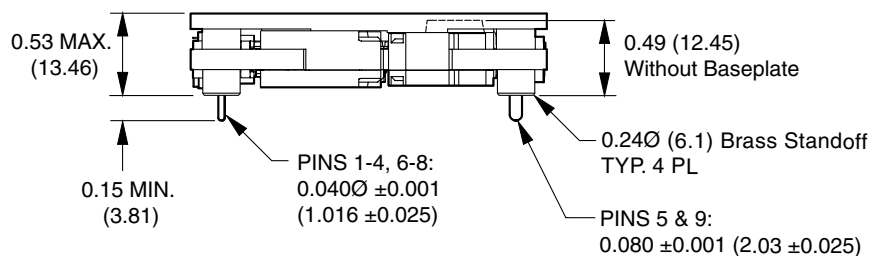


**MECHANICAL SPECIFICATIONS**

Case C66



I/O CONNECTIONS	
Pin	Function P17
1	-Input
2	Case
3	On/Off Control
4	+Input
5	+Output
6	+Sense
7	Trim
8	-Sense
9	-Output



**BOTTOM VIEW**

DIMENSIONS ARE IN INCHES (MM)

**UHP Converter Series Mounting**

The UHP series include a multilayer planar-magnetic Printed Circuit Board (PCB), high-current Input/Output pins, four removable brass mounting standoffs and an optional machined aluminum baseplate. See Mechanical Specifications.

A user's installation will normally have a host PCB to solder to the converter's I/O pins. To avoid placing the full mechanical mounting load on the I/O pins, we recommend that the user's PCB also includes bolts through the PCB to assemble to the standoffs. Note the #M3 metric threading of the standoffs. Avoid excessive torque assembling the bolts to the standoffs. Use lock washers or locking compound to avoid loosening of the mounting bolts.

The standoffs include machined shoulders so that mechanical force is not placed against the converter's power components. To avoid long-term oxidation of the host PCB, be sure to accommodate the relatively high temperatures of the power components adjacent to the user's host PCB. Normally, a planar grounded area of copper etch on the PCB surface will be sufficient to spread the heat, reduce electrical noise and avoid hotspots. A relief dimension on the standoffs floats the power components 0.02 inches minimum from the user's host PCB.

The baseplate is in thermal contact with the power components and practically all the converter's internal heat dissipation is conducted away via the baseplate. Users typically have two choices to remove this thermal load—either an extruded aluminum finned heat sink or a thermal mounting surface such as a chassis wall. The heatsink depends on ambient temperature, airflow and total power extracted from the converter, depending on the input voltage and converter efficiency. Do not attempt to conduct all baseplate heat solely through the standoffs. Use either a thermal pad or thermal mounting compound ("thermal grease") when attaching the baseplate to its mounting surface. Keep baseplate temperature below +110°C. Study the Derating Curve.

For chassis wall mounting, the user must consider the tolerance buildup—the host PCB, mounting standoffs, thermal pad and placement of the chassis wall. Measure carefully to avoid unwanted mechanical stresses.