beta dyne

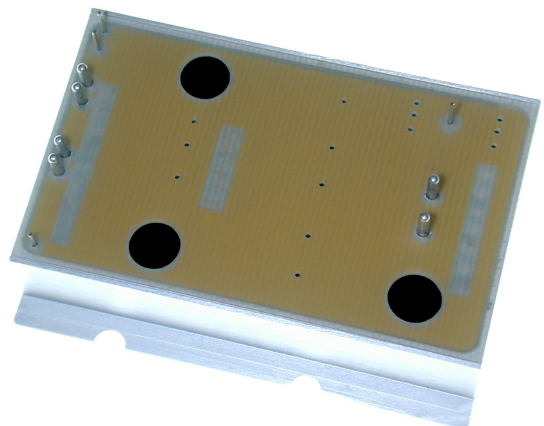
BD75001

75W Single DC/DC Converter

18–36V_{IN}, 5V_{OUT}@15A

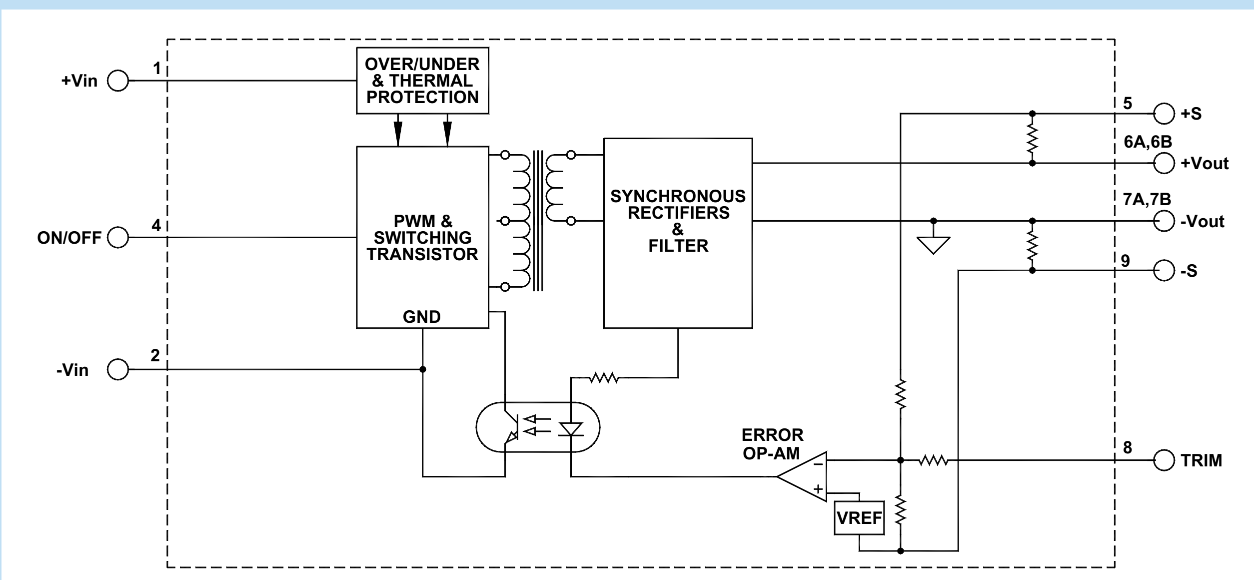
Key Features

- 89% efficiency
- 50µS transient response time
- 150µA off state current
- Output synchronous rectification
- 2:1 input voltage range
- Input-to-output isolation
- Soft start
- Short circuit protection
- Thermal protection
- Undervoltage protection



Functional Description

The BD75001 is a 75W single output DC/DC converter based on Beta Dyne's PowerWatt series designed to accept 18–36V_{IN} and provide 5V_{OUT}@15A nominal. The converter is packaged in a 2.3×1.75×0.5-inch aluminum heat sink that extends its operating temperature range and reduces radiated noise.



Typical Block Diagram

Unless otherwise specified, all parameters are given under typical ambient temperature of +25°C with an airflow rate = 400LFM. With the given power derating, the operating range is -40°C to +125°C. Specifications subject to change without notice.

Electrical Specifications

ABSOLUTE MAXIMUM RATINGS

PARAMETER / VALUE / UNIT	PARAMETER / VALUE / UNIT
Input Voltage Non-operating............ 75V continuous Operating............ 75V contnuous Input/Output Isolation............ 1500Vdc Operating Temperature............ -40 to +71°C Storage Temperature............ -55 to +125°C	Voltage at On/Off Input Pin............ +40/-1Vdc Semiconductor Junction Temperature.......... 150°C PCB Operating Temperature............ 150°C Pins Current Rating............ 30A@25°C Output Capacitance............ 20,000µF

INPUT SPECIFICATIONS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Input Voltage Range		18	24	36	Vdc
Input Startup Voltage, $24V_{IN}$				16.5	Vdc
Undervoltage Shutdown, $24V_{IN}$		16			Vdc
Input Filter	Capacitor				
Reflected Ripple	See Figure 1		80		mA_{PP}
No Load Input Current			120		mA
Full Load Input Current	V_O = 5V, I_O = 15A		3511		mA
Input Surge Current (20µS Spike)				10	A
Short Circuit Current Limit			125	150	% I_{IN} Max
Off State Current			150		µA
Remote ON/OFF Control					
Supply ON	Pin 4 Open (Open circuit voltage: 12V Max.)				
Supply OFF		0		0.8	Vdc
Logic Input Reference					
Logic Compatibility	TTL Open Collector or CMOS Open Drain				

OUTPUT SPECIFICATIONS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Output Voltage			5		Vdc
Output Current			15		A
Output Voltage Accuracy			±1		%
Output Voltage Adjustment			±5		%
Output Capacitance		100	220	1000	µF
Ripple & Noise			1	2	$\%V_{PP}$ of V_{OUT}
Line Regulation	Minimum V_{IN} to maximum V_{IN}		±0.25	±0.5	%
Load Regulation	10% FL to FL		±0.25	±0.5	%
Output Minimum Load		5	10		%
Temperature Coefficient @ FL			0.02		%/°C
Transient Response Time	50% FL to FL to 50% FL		50	100	µS
Short Circuit Protection	By input current limiting				
Turn On Delay with Soft Start	See Figure 2		3	4	mS
Output Overvoltage Protection	None,				

GENERAL SPECIFICATIONS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Efficiency	Full Load		89		%
Isolation Voltage (1 min.), Input to Output			1500		Vdc
Isolation Resistance			10^9		Ω
Isolation Capacitance			300		pF
Switching Frequency			400		kHz

ENVIRONMENTAL SPECIFICATIONS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Operating Temperature Range (Ambient)	Industrial	-40		+71	°C
Storage Temperature Range		-55		+150	°C
Maximum Operating PCB Temperature	(Not Ambient)			125	°C
Thermal Resistance, With Heat Sink[3]	Zero air flow		7.8		°C/W
MTBF	per MIL-HNBK-217F (Ground benign, +25°C)		1.1×10^6		hours

PHYSICAL CHARACTERISTICS

PARAMETER	CONDITION / NOTE	MIN	TYP	MAX	UNIT
Dimensions (L×W×H)	2.30×1.75×0.50 in. (58.42×44.45×12.70mm)				
Weight	2.34 oz. (66.1g)				

[1] Measured with 100µF capacitor for $24V_{IN}$ at the input power pins in series with 10µH inductor (see Figure 1).
[2] The maximum input current at any given input range measured at minimum input voltage is given as $1.6{*}I_{NOMINAL}$. Nominal input current is the typical value measured at the input of the converter under full-load room temperature and nominal input voltage (24Vdc and 48Vdc).
[3] See Application Note DC-004: Thermal Considerations for DC/DC Converters.

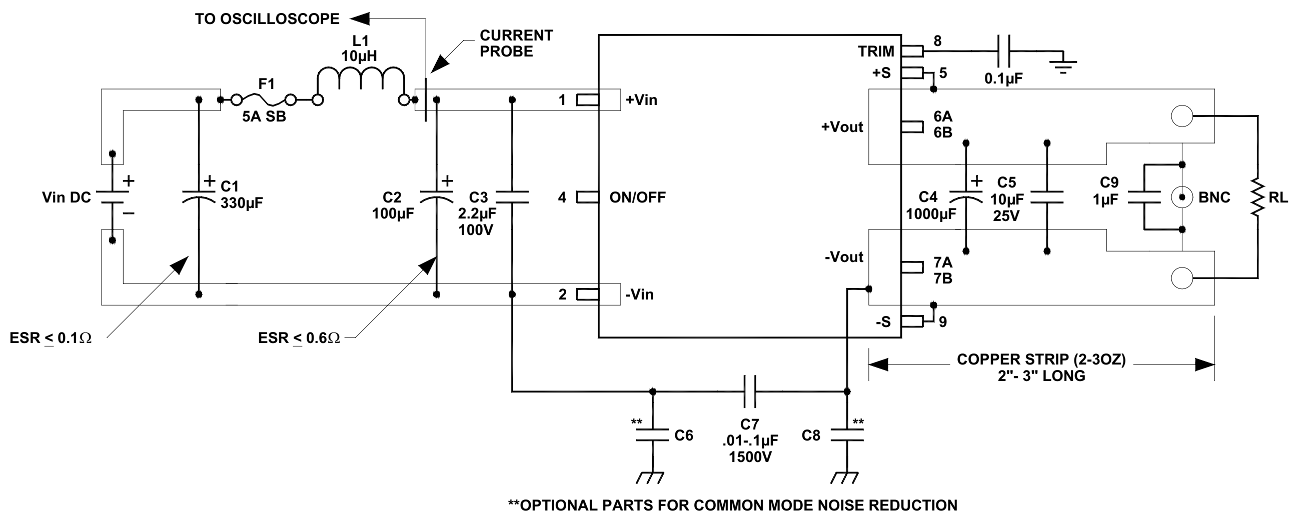


FIGURE 1. Setup for output and reflected ripple measurement

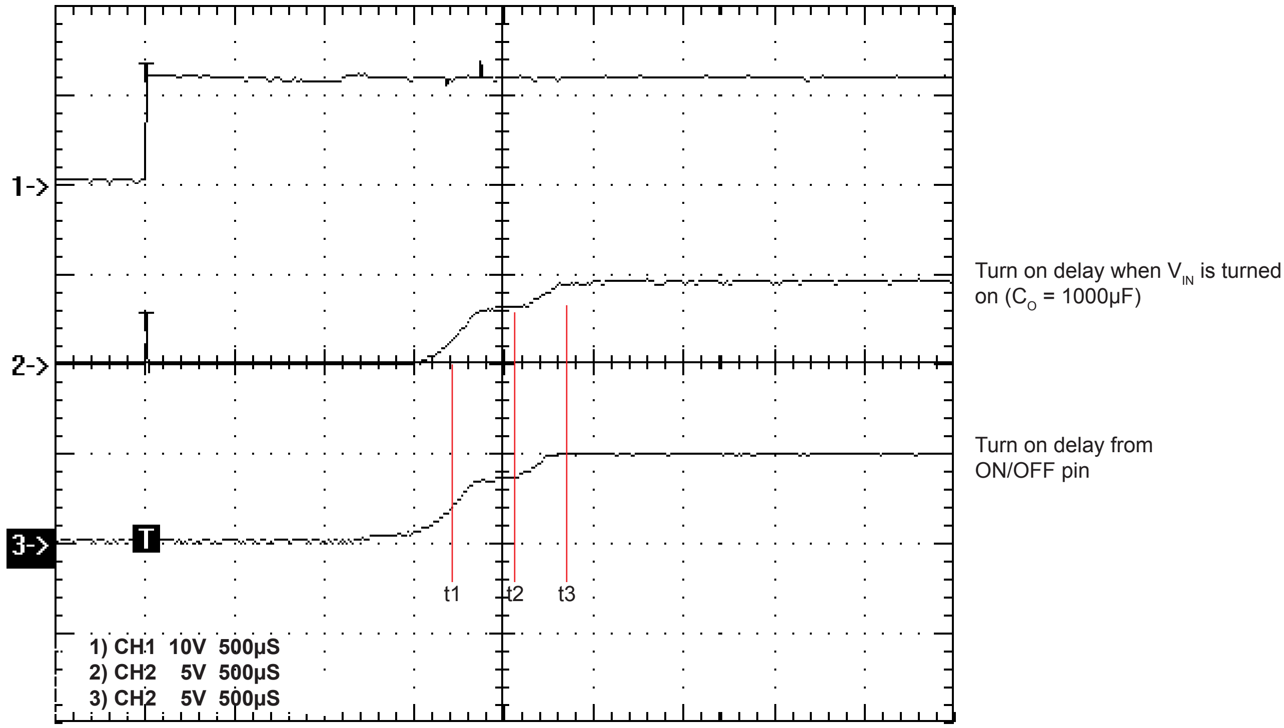


FIGURE 2. Turn on delays

NOTE: From t1 to t2, the secondary voltage is rectified by the MOSFET parasitic diodes. From t2 to t3, a switchover from diode rectification to synchronous rectification occurs.

EXTERNAL TRIMMING OF OUTPUT VOLTAGES

To trim the output voltage DOWN, connect a 5% ¼W resistor between the + (plus) output and trim pin of the converter. To trim the output voltage UP, connect a 5% ¼W resistor between the – (minus) output and trim pins of the converter. For UP/DOWN trimming capability, connect a 10kΩ potentiometer between the + and – output pins, with the wiper arm connected to the trim pin.

The trim resistors/potentiometer can be connected at the converter output pins or the load. However, if connected at the load, the resistance of the runs becomes part of the feedback network which improves load regulation. If the load is some distance from the converter, the use of #20 gauge wire is recommended to avoid excessive voltage drop due to the resistance of the circuit paths.

See our application notes:
DC-001: Testing Transient Response in DC/DC Converters
DC-004: Thermal Consideration for DC/DC Converters

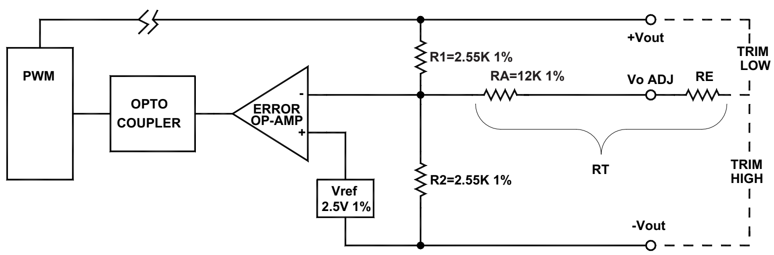


FIGURE 3. Output control circuit

To trim V_O higher to V_O', where V_O is the actual measured untrimmed value:

$$RE = RT - RA = \frac{R1 * V_{REF}}{V_O' - V_O} - RA$$

To trim V_O lower to V_O'', where V_O is the actual measured untrimmed value:

$$RE = RT - RA = \left[\left(\frac{R_1^2 * V_{REF}}{R_2(V_O - V_O'')} - R1\right) - RA\right]$$

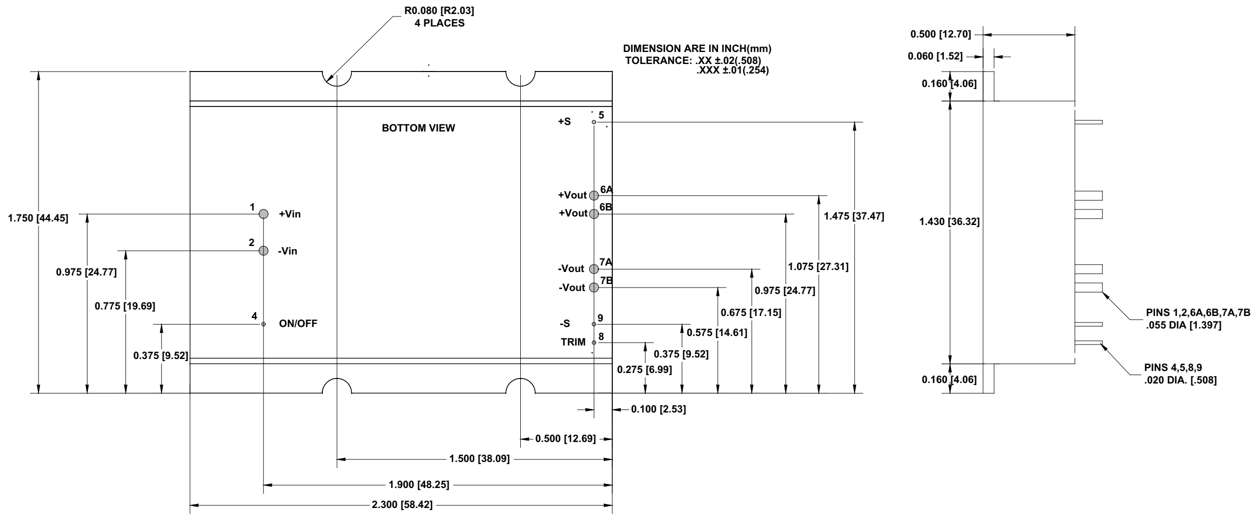
EXAMPLE

To trim V_O from 1.8V to 2V:

V_O = 1.8V, V_O' = 2V, R1 = 1.13kΩ, V_{REF} = 1.25, RA = 2kΩ

RE = RT - RA = (1.13*1.25)/(2-1.8) - 2kΩ = 5.06kΩ *or* approx. 5.1kΩ (a standard resistor value)

MECHANICAL SPECIFICATIONS
With Heat Sink



Pin	Function
1	$+V_{IN}$
2	$-V_{IN}$
4	ON/OFF
5	+S
6A, 6B	$+V_{OUT}$
7A, 7B	$-V_{OUT}$
8	Output Voltage Trim
9	-S ($-V_{OUT}$ Sense)

APPLICATION CONSIDERATIONS

Pin Functions

$+V_{IN}$ (Pin 1): For positive input power supply connections.

$-V_{IN}$ (Pin 2): For negative input power supply connection (or input ground).

ON/OFF (Pin 4): Turns converter off when pulled to ground through an open collector or open drain transistor. Maximum voltage at this pin is 12V minus a diode drop. Can be parallel connected with the ON/OFF pins of multiple converters or any Beta Dyne converter that may reside in the system. Leave this pin open for continuous operation.

+S (Pin 5): Positive output voltage sense; to be connected to the positive output voltage at the load only.

$+V_{OUT}$ (Pins 6A, 6B): Positive output voltage.

$-V_{OUT}$ (Pins 7A, 7B): Negative output (GND).

Trim (Pin 8): Output voltage adjust; to be used for an output voltage adjustment. Bypass this pin with a 0.01µF to 0.10µF capacitor.

-S (Pin 9): Negative output voltage sense; to be connected to the negative output at the load only.

DESIGN CONSIDERATIONS

Input Source Impedance

The input of the converter should be connected to a low AC-impedance source. To reduce the impedance of a potentially high-inductive DC source, use a low ESR electrolytic capacitor (ESR < 0.6W@400kHz) mounted as close to the input pins as possible to ensure stability of the converter. As suggested in Figure 1, an electrolytic capacitor (22µF for 48V_{IN}) in parallel with an SMD 2.2µF ceramic capacitor will ensure stability under any line or load condition. The 330µF capacitor before the input inductor L1 will reduce both reflected ripple and any long wire impedance from the DC source.

Output Filter Impedance

The impedance of an output filter may also affect the stability of a converter when additional low-pass filters are used. If additional output ripple reduction is required, avoid installing series inductors at the output. Instead, try to maximize output capacitance. The inductor of the output copper strips and a 1000µF capacitor will be enough for most applications. Low ESR electrolytic or tantalum capacitors can be used for additional output ripple reduction in parallel with ceramic capacitors for high-frequency attenuation. We recommend Vishay Sprague 594D Solid Tantalum Chip Capacitors.

THERMAL CONSIDERATIONS

Under full load, the converter dissipates from 6W to 10W of power. The generated heat is transferred to the ambient by air conduction. At room temperature without any air movement, the operating environment of the converter is higher than room temperature, 25°–50°C higher, due to the fact that air around the converter heats up.

To measure the actual operating environment of the converter in a still air environment, place a thermocoupler a half-inch above the top center of the converter. Perform the same temperature measurement in a forced air convection system and use those temperature values for your thermal calculations. Do not assume the temperature is constant throughout a forced air cooling system! Surrounding components and the load can cause the converter to go to thermal shutdown.

The minimum junction temperature of all semiconductors is 150°C and the maximum operating temperature of the PCB is 150°C. When the temperature of the PCB reaches approximately 125°C, the converter will turn off. The thermal hysterisis of 20°–30°C will allow the converter to cool off and resume operation once it reaches approximately 95°C. If there is not enough air circulation due to air fan failure of the system or very high environmental temperatures, the converter will stay in this so-called “hiccup” (ON/OFF) thermal mode indefinitely.

SHORT CIRCUIT PROTECTION

The converter has a dual short circuit protection feature. At the input side of the converter, two short circuit current comparators are used to monitor the input current of the converter. They are biased at different voltage levels; the lower threshold (LTH) comparator provides the power limiting function of the converter. Under normal operating conditions, the LTH comparator limits the output power of the converter when the maximum output power is exceeded. When a hard short is applied across the output of the converter and the input current exceeds the set threshold of the second comparator, the converter goes into shutdown mode, the overcurrent latch is set and the converter is turned off. The converter will turn on again when its input voltage is recycled (OFF–ON) or if the ON/OFF pin is used to turn the converter on and off. The time required for the ON/OFF pin to be held low is between 100mS and 800mS.