PT4560 Series—48V

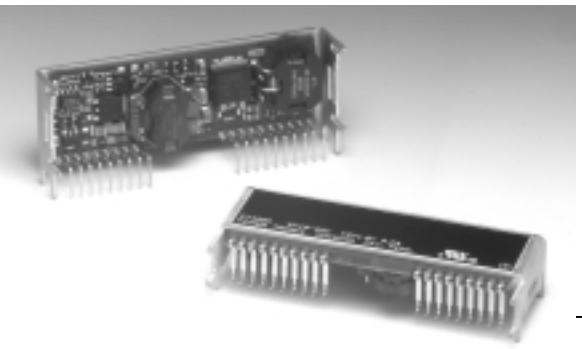
30 Watt 48V Input
Isolated DC-DC Converter

EXCALIBUR

Power Trends Products from Texas Instruments

SLTS097

(Revised 6/30/2000)

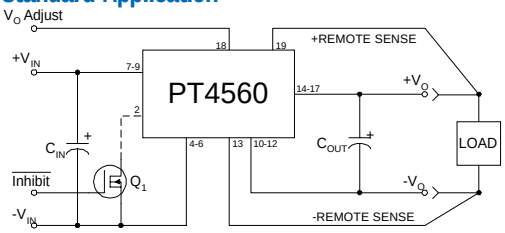


The PT4560 is a new series of 30 Watt, isolated DC to DC converters housed in a unique 19-pin, thermally efficient package. The 36 to 75V input range allows easy integration into many distributed power applications which utilize 48V bus architectures.

The PT4560 series is available with output voltages from 1.8V to 15V. The output voltage is adjustable from 90 to 110% of nominal with the addition of an external resistor. Other features include an inhibit function and differential remote sense to compensate for any voltage drop between the converter and the load. The PT4560 includes built in current limit, short circuit protection and over-temperature shutdown.

A 330µF output capacitor is required for proper operation.

Standard Application



C_{in} = Optional 100µF/100V electrolytic
C_{out} = Required 330µF electrolytic (1)
Q_1 = NFET

Pin-Out Information

Pin	Function	Pin	Function
1	Do Not Use	10	-V_o
2	Inhibit(4)	11	-V_o
3	Do Not Use	12	-V_o
4	-V_{in}	13	-Remote Sense
5	-V_{in}	14	+V_o
6	-V_{in}	15	+V_o
7	+V_{in}	16	+V_o
8	+V_{in}	17	+V_o
9	+V_{in}	18	V_o Adjust(4)
		19	+Remote Sense

Features

- Input Voltage Range: 36V to 75V
- 1500 VDC Isolation
- V_o Inhibit
- V_o Adjust
- Differential Remote Sense
- Current Limit
- Short-Circuit Protection
- Over-Temperature Shutdown
- Undervoltage Lockout
- Excalibur™ Package
- UL1950 recognized
- CSA 22.2 950 certified
- EN60950 Approved
- VDE Licensed
- Within FCC Class A Radiated Limits

Preliminary Specifications

Characteristics (T_a = 25°C unless noted)	Symbols	Conditions	PT4560 SERIES Min	Typ	Max	Units
Output Current	I_o	Over V_{in} range V_o = 3.3V	0.25	—	8.0	A
		V_o = 5V	0.25	—	6.0	A
		V_o = 12V	0.1	—	2.5	A
On/Off Standby Current	$I_{in\ standby}$	V_{in} = 48V, Pin 1 = -V_{in}	—	8	16	mA
Short Circuit Current	I_{sc}	V_{in} = 48V	—	2xI_{omax}	—	A
Input Voltage Range	V_{in}	Over I_o Range	36.0	48.0	75.0	V
Output Voltage Tolerance	ΔV_o	Over V_{in} Range T_A= -40°C to +85°C	—	±1.0	±2.0	%V_o
Line Regulation	Reg_{line}	Over V_{in} range @ max I_o	—	±0.5	±1.0	%V_o
Load Regulation	Reg_{load}	10% to 100% of I_o max	—	±0.5	±1.0	%V_o
V_o Ripple/Noise	V_n	V_{in}=48V, I_o=I_o max, V_o≥5V	—	1.0	2.0	%V_o
		V_{in}=48V, I_o=I_o max, V_o<5V	—	50	75	mV_{pp}
Transient Response	t_{tr}	50% load change, 1A/µSec	—	100	200	µSec
		V_o over/undershoot, V_o≥5V	—	3.0	5	%V_o
Efficiency	η	V_{in}=48V, I_o=6A, V_o=3.3V	—	80	—	%
		V_{in}=48V, I_o=6A, V_o=5V	—	84	—	%
		V_{in}=48V, I_o=2.5A, V_o=12V	—	85	—	%
Switching Frequency	f_o	Over V_{in} and I_o V_o<10V	600	750	900	kHz
		V_o≥10V	400	500	600	
Maximum Operating Temperature Range	T_a	V_{in} = 48V @ max I_o Airflow = 200 LFM	-40 (1)	—	+85 (2)	°C
Storage Temperature	T_s	—	-40	—	+125	°C
Mechanical Shock	—	Per Mil-Std-883D, method 2002.3, 1mS, half-sine, mounted to a fixture	—	500	—	G's
Mechanical Vibration	—	Per Mil-Std-883D, method 2007.2, 20-2000Hz, soldered in a PC board	—	10	—	G's
Weight	—	—	—	40	—	grams
Input/Output Isolation	—	—	1500	—	—	VDC
Capacitance	—	—	—	1200	—	pF
Resistance	—	—	10	—	—	MΩ
Flammability	—	Materials meet UL 94V-0				
Inhibit (pin 2)	On (3)	Referenced to -V_{in}	2.5	—	15	VDC
	Off		0	—	0.8	VDC

Notes: *(1) At temperatures below 0°C the PT4560 requires capacitors with temperature stable dielectrics, such as tantalum or Oscon.*
(2) See Safe Operating Area curves, or cantact the factory for the appropriate derating.
(3) If pin 2 is left open, the PT4560 will operate when input power is applied.
(4) See Application Notes at end of section.

Ordering Information

PT4561☐ = 3.3V/8A
PT4562☐ = 5.0V/6A
PT4563☐ = 12.0V/2.5A
PT4564☐ = 15.0V/2A
PT4565☐ = 2.0V/8A
PT4566☐ = 2.5V/8A
PT4567☐ = 1.8V/8A
PT4568☐ = 5.2V/6A

PT Series Suffix (PT1234X)

Case/Pin Configuration	
Vertical Through-Hole	N
Horizontal Through-Hole	A
Horizontal Surface Mount	C

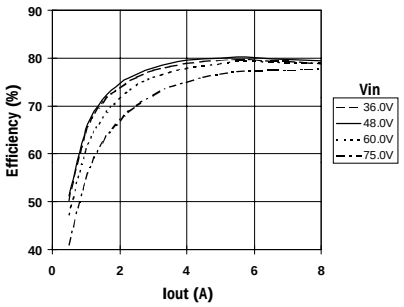
(For dimensions and PC board layout, see Package Styles 1400 and 1410.)

Note: This product is the subject of one or more patents. Other patents pending.

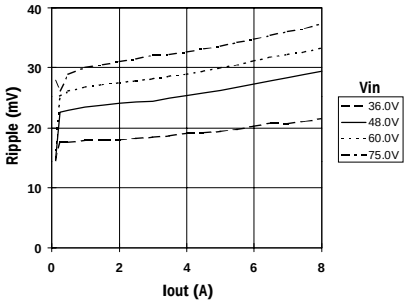
Typical Characteristics

PT4561, 3.3 VDC (See Note A)

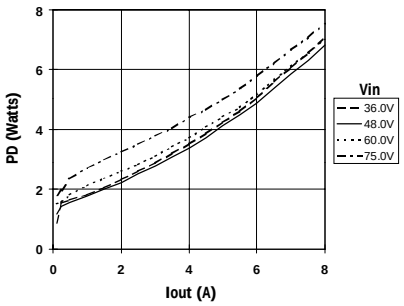
Efficiency vs Output Current



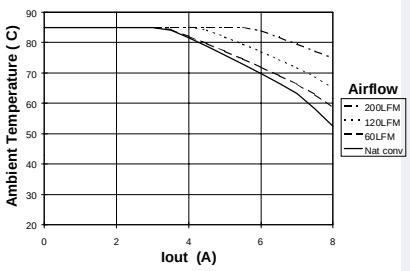
Ripple vs Output Current



Power Dissipation vs Output Current

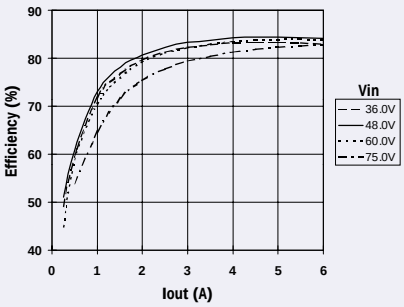


Safe Operating Area (V_{in} =48V)

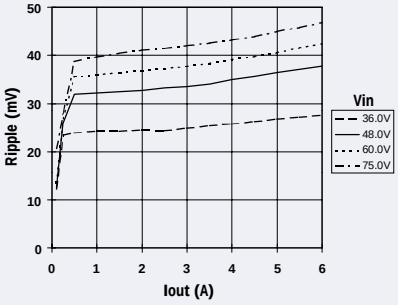


PT4562, 5.0 VDC (See Note A)

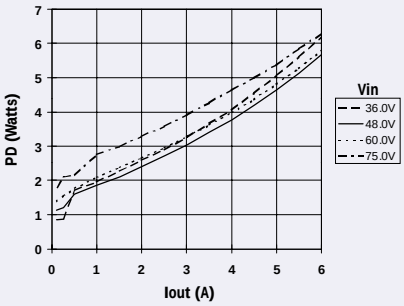
Efficiency vs Output Current



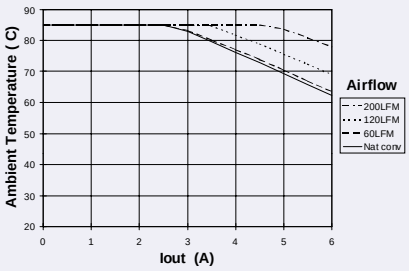
Ripple vs Output Current



Power Dissipation vs Output Current

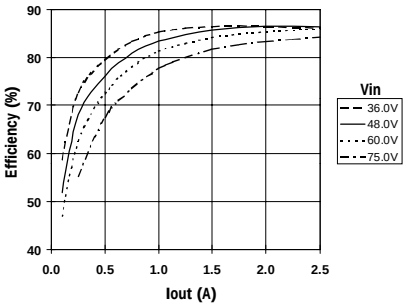


Safe Operating Area (V_{in} =48V)

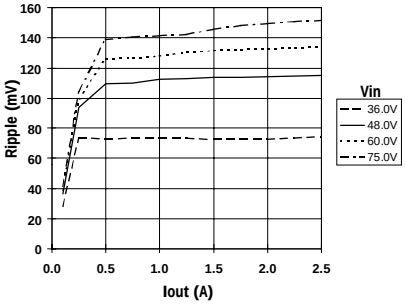


PT4563, 12.0 VDC (See Note A)

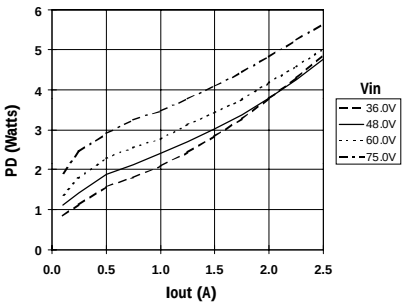
Efficiency vs Output Current



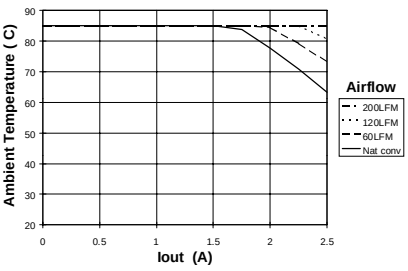
Ripple vs Output Current



Power Dissipation vs Output Current



Safe Operating Area (V_{in} =48V)



Note A: *All data listed in the above graphs has been developed from actual products tested at 25°C. This data is considered typical data for the DC-DC Converter.*
Note B: *SOA curves represent operating conditions at which internal components are at or below manufacturer's maximum rated operating temperature.*

Adjusting the Output Voltage of Power Trends' 30W Isolated DC-DC Converter Series

The factory pre-set output voltage of Power Trends' 30W series of isolated DC-DC converters may be adjusted within a nominal ±10% range. This is accomplished with the addition of a single external resistor. For the input voltage range specified in the data sheet, Table 1 gives the allowable adjustment range for each model as V_o (min) and V_o (max).

Adjust Up: An increase in the output voltage is obtained by adding a resistor, R2 between pin 18 (V_o adjust), and pin 13 (-Remote Sense). *See note 4.*

Adjust Down: Add a resistor (R1), between pin 18 (V_o adjust) and pin 19 (+Remote Sense).

Refer to Figure 1 and Table 2 for both the placement and value of the required resistor, (R1) or R2.

Notes:

1. Use only a single 1% resistor in either the (R1) or R2 location. Place the resistor as close to the ISR as possible.
2. Never connect capacitors to V_o adjust. Any capacitance added to the V_o adjust control pin will affect the stability of the ISR.
3. If the remote sense pins are not being used, the resistors (R1) and R2 can be connected to $+V_{out}$ or $-V_{out}$ respectively.
4. The adjusted output voltage, V_a effectively sets the voltage across pins 13 and 19 (±Remote Sense). When using the remote sense pins, V_{out} (measured directly across pins 10–12, and 14–17) can be significantly higher than V_a, and may exceed V_o (max). If V_a is adjusted upward of V_o(max), the the minimum input voltage is increased by the same percentage as V_{out} exceeds V_o(max).

The values of (R1) [adjust down], and R2 [adjust up], can also be calculated using the following formulas.

$$(R1) = \frac{K_o (V_a - V_r)}{V_r (V_o - V_a)} - R_s \quad k\Omega$$

$$R2 = \frac{K_o}{(V_a - V_o)} - R_s \quad k\Omega$$

Where V_o = Original output voltage
V_a = Adjusted output voltage
V_r = Reference voltage (Table 1)
K_o = Multiplier constant (Table 1)
R_s = Series resistance (Table 1)

Table 1

DC-DC CONVERTER ADJUSTMENT RANGE AND FORMULA PARAMETERS

Series Pt #							
AL Case:							
24V Bus				**PT3341**	**PT3342**	**PT3343**	**PT3344**
48V Bus	**PT3327**	**PT3325**	**PT3326**	**PT3321**	**PT3322**	**PT3323**	**PT3324**
CU Case:							
24V Bus	**PT4585**			**PT4581**	**PT4582**	**PT4583**	**PT4584**
48V Bus	**PT4567**	**PT4565**	**PT4566**	**PT4561**	**PT4562**	**PT4563**	**PT4564**
V_o(nom)	1.8V	2.0V	2.5V	3.3V	5.0V	12.0V	15.0V
Vo(min)	1.62V	1.8V	2.25V	2.95V	4.5V	10.8V	13.5V
Vo(max)	1.98V	2.2V	2.75V	3.65V	5.5V	13.2V	16.5V
V_r	1.225V	1.225V	1.225V	1.225V	1.225V	2.5V	2.5V
K_o (V·kΩ)	69.58	62.47	42.33	68.89	68.71	135.9	137.5
R_S (kΩ)	80.6	150.0	121.0	150.0	121.0	90.9	80.6

Figure 1

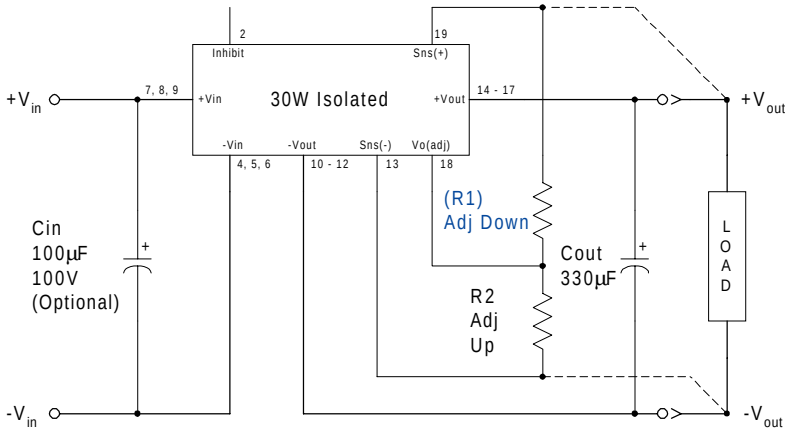


Table 2

DC-DC CONVERTER ADJUSTMENT RESISTOR VALUES

Series Pt #									
AL Case									
24V Bus			**PT3341**	**PT3342**		**PT3343**		**PT3344**	
48V Bus	**PT3327**	**PT3325**	**PT3326**	**PT3321**		**PT3322**		**PT3323**	**PT3324**
CU Case									
24V Bus	**PT4585**			**PT4581**		**PT4582**		**PT4583**	**PT4584**
48V Bus	**PT4567**	**PT4565**	**PT4566**	**PT4561**		**PT4562**		**PT4563**	**PT4564**
Current	**8Adc**	**8Adc**	**8Adc**	**8Adc**		**6adc**		**2.5Adc**	**2.0Adc**
V_o(nom)	**1.8V**	**2.0Vdc**	**2.5Vdc**	**3.3Vdc**		**5.0Vdc**		**12.0Vdc**	**15.0Vdc**
V_a(req'd)					**V_a(req'd)**		**V_a(req'd)**		
1.65	(39.9)kΩ				4.5	(246.0)kΩ	10.8	(285.0)kΩ	
1.7	(149.0)kΩ				4.55	(293.0)kΩ	11.0	(371.0)kΩ	
1.75	(475)kΩ				4.6	(352.0)kΩ	11.2	(500.0)kΩ	
1.8					4.65	(428.0)kΩ	11.4	(715.0)kΩ	
1.85	1270.0kΩ	(62.5)kΩ			4.7	(529.0)kΩ	11.6	(1150.0)kΩ	
1.9	575.0kΩ	(194.0)kΩ			4.75	(670.0)kΩ	11.8		
1.95	343.0kΩ	(589.0)kΩ			4.8	(882.0)kΩ	12.0		
2.0					4.85	(1230.0)kΩ	12.2	588.0kΩ	
2.05		1100.0kΩ			4.9	(1940.0)kΩ	12.4	249.0kΩ	
2.1		475.0kΩ			4.95		12.6	136.0kΩ	
2.15		266.0kΩ			5.0		12.8	78.9kΩ	
2.2		162.0kΩ			5.05		13.0	45.0kΩ	
2.25			(20.7)kΩ		5.1	566.0kΩ	13.2	22.3kΩ	
2.3			(64.7.0)kΩ		5.15	337.0kΩ			
2.35			(138.0)kΩ		5.2	223.0kΩ	13.5		(323.0)kΩ
2.4			(285.0)kΩ		5.25	154.0kΩ	13.6		(355.0)kΩ
2.45			(726.0)kΩ		5.3	108.0kΩ	13.8		(437.0)kΩ
2.5					5.35	75.3kΩ	14.0		(522.0)kΩ
2.55			726.0kΩ		5.4	50.8kΩ	14.2		(724.0)kΩ
2.6			302.0kΩ		5.45	31.7kΩ	14.4		(1010.0)kΩ
2.65			161.0kΩ		5.5	16.4kΩ	14.6		(1580.0)kΩ
2.7			90.6kΩ				14.8		
2.75			48.3kΩ				15.0		
2.95				(127.0)kΩ			15.2		607.0kΩ
3.0				(183.0)kΩ			15.4		263.0kΩ
3.05				(261.0)kΩ			15.6		149.0kΩ
3.1				(377.0)kΩ			15.8		91.3kΩ
3.15				(572.0)kΩ			16.0		56.9kΩ
3.2				(961.0)kΩ			16.5		11.1kΩ
3.25				(2130.0)kΩ					
3.3									
3.35				1230.0kΩ					
3.4				539.0kΩ					
3.45				309.0kΩ					
3.5				194.0kΩ					
3.55				126.0kΩ					
3.6				79.6kΩ					
3.65				46.8kΩ					

R1 = (Blue) R2 = Black

Using the Inhibit Function on the Power Trends' 30W Isolated DC-DC Converter Series

For applications requiring output voltage on/off control, the Power Trends' 30W isolated series of DC-DC converters incorporate an inhibit function. This function may be used in applications that require battery conservation, power-up/shut-down sequencing, and/or to co-ordinate the power-up of the regulator for active in-rush current control. (See the related application note, AN21).

The inhibit function is provided by the *Inhibit* control, pin2. If pin 2 is left open-circuit, the converter provides a regulated output whenever a valid source voltage[4] is applied between $+V_{in}$(pins 7-9), and $-V_{in}$ (pins 4-6). Applying a low-level ground signal[2] to pin 2 will disable the regulator output. The inhibit control is also compatible with some logic families. Table 1 provides details of the logic threshold requirements for the inhibit input. Figure 1 shows how either a discrete MOSFET (Q_1) or a logic gate ($U1_a$)[5], may be referenced to the negative input voltage rail and used with the inhibit control.

Table 1 Inhibit Control Thresholds [2]

Parameter	min	max	
Enable (VIH)	2.5V	15.0V	(or Open Circuit) 5
Disable (VIL)	–0.3V	0.8V	

Notes:

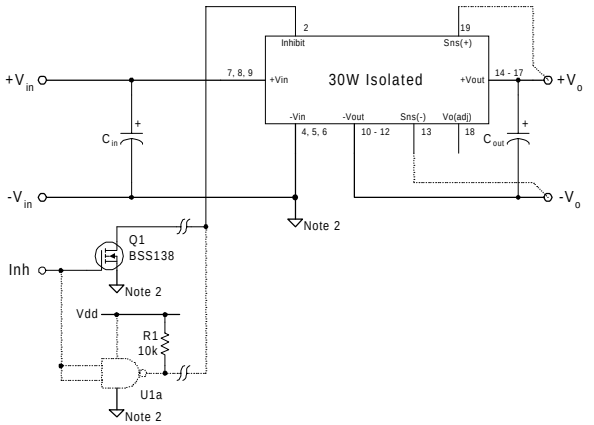
1. The inhibit control logic is similar for all Power Trends' modules, but the flexibility and threshold tolerances will be different. For specific information on this function for other converters, consult the applicable application note.
2. The inhibit control pin uses $-V_{in}$ (pins 4-6) as its ground reference. All voltages specified are with respect to $-V_{in}$.
3. The inhibit control internal circuitry comprises of a high impedance 10µA current source. The open-circuit voltage may be as high as 8.3Vdc.
4. These converters incorporate an "Under Voltage Lockout" (UVLO) function. This function automatically inhibits the converter output until there is sufficient input voltage for the converter to produce a regulated output. Table 2 gives the applicable UVLO thresholds.

Table 2 UVLO Thresholds [2]

Series	UVLO Threshold	V_{in} Range
PT3320/4560	33 ± 2.0V	36 – 75V
PT3340/4580	15.5 ± 1.5V	18 – 60V

5. The inhibit pin may be controlled using devices with either an open-collector or differential output. With a bipolar transistor or MOSFET, select a low-leakage part (<1µA). A pull-up resistor is not necessary. If a logic gate is used a pull-up resistor may be required to the logic supply voltage, V_{dd}. This is to ensure that the gate output exceeds V_{IH}(min) (see Table 1). *Do not* use a pull-up resistor to the $+V_{in}$ input, or drive the inhibit pin above V_{IH}(max).
6. When the converter output is disabled the current drawn from the input supply is typically reduced to 8mA (16mA maximum).
7. Keep the on/off transition to less than 1ms. This prevents erratic operation of the ISR, whereby the output voltage may drift un-regulated between 0V and the rated output during power-up.

Figure 1



Turn-On Time: When the Inhibit pin is left open-circuit, the output of the regulator is automatically enabled when a valid input voltage[4] is applied to the input power pins. The converter typically produces a fully regulated output voltage within 30-ms of the application of power, or the release of the inhibit pin with input power applied. The actual turn-on time will vary with the input voltage, output load, and the total amount of capacitance connected to the output Using the circuit of Figure 1, Figure 2 shows the typical output voltage and input current waveforms of a PT3322/PT4562 after Q1 is turned off at time t = 0s. The waveform was measured with a 48Vdc input voltage, and 1-ohm resistive load.

Figure 2