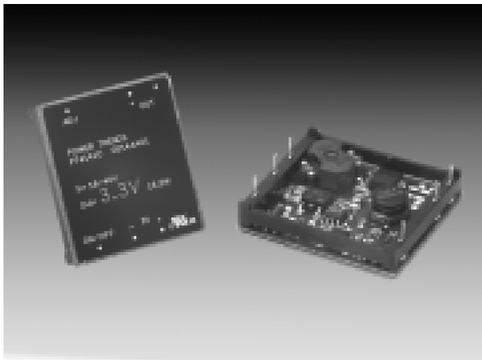
20-W 24-V Input Isolated DC/DC Converter

SLTS120B
(Revised 3/1/2002)



Features

- Input Voltage Range: 18V to 40V
- 20W Rated
- 82% Efficiency
- 1500 VDC Isolation
- Low Profile (8.5 mm)
- Small Footprint: 1.52in x 1.73in
- Remote On/Off
- Short Circuit Protection
- Over Temperature Shutdown
- Under-Voltage Lockout
- UL1950 Recognized
- CSA 22.2 950 Certified
- EN60950 Approved
- 4×10^6 Hrs MTBF

Description

The PT4140 power modules are a series of isolated DC/DC converters housed in a low-profile package. Rated for 20 watts or 5A, the series includes standard output voltages ranging from as low as 1.5VDC to 15VDC. The output may be adjusted up to ±10% of nominal. These converters are ideal for Telecom, Industrial, Computer, and other distributed power applications that require input-to-output isolation.

Using multiple PT4140 modules, system designers can implement a complete custom power supply solution. The flexibility of full isolation also allows the input or output to be configured for negative voltage operation.

The PT4140 series requires no additional components for proper operation.

Ordering Information

PT4141❒	=	3.3V/5A	(16.5W)
PT4142❒	=	5.0V/4A	
PT4143❒	=	12.0V/1·6A	
PT4144❒	=	15.0V/1·3A	
PT4146❒	=	1.5V/5A	(7.5W)
PT4147❒	=	1.8V/5A	(9W)
PT4148❒	=	2.5V/5A	(12.5W)

PT Series Suffix (PT1234x)

Case/Pin Configuration	Order Suffix	Package Code *
Horizontal	A	(EGD)
SMD	C	(EGE)

** Previously known as package style 710.*

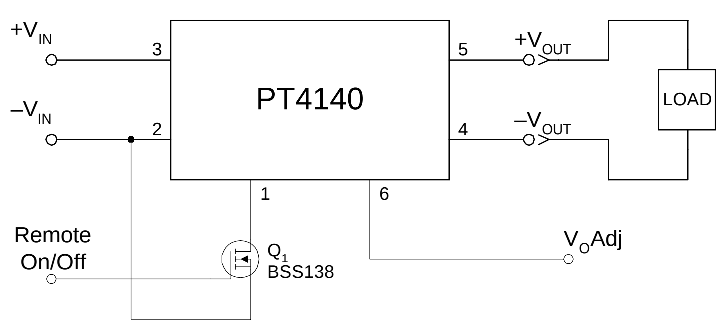
(Reference the applicable package code drawing for the dimensions and PC board layout)

Pin-Out Information

Pin	Function
1	Remote On/Off †
2	$-V_{in}$
3	$+V_{in}$
4	–Vout
5	+Vout
6	V_{out} Adjust †

† For further information, see application notes.

Standard Application



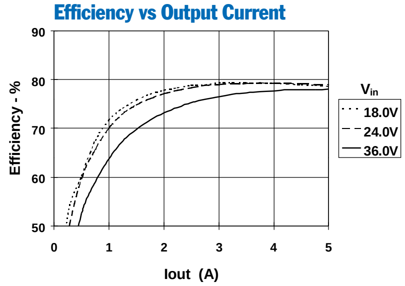
Specifications (Unless otherwise stated, T_a =25°C, V_{in} =24V, C_{out} =0µF, and I_o =$I_o$max)

Characteristic	Symbol	Conditions		PT4140 SERIES Min	Typ	Max	Units
Output Current	I_o	Over V_{in} range	V_o = 15V V_o = 12V V_o =5.0V V_o ≤3.3V	0.1 (1) 0.1 (1) 0.1 (1) 0.1 (1)	— — — —	1.3 1.6 4.0 5.0	A
Input Voltage Range	V_{in}	Over I_o Range		18.0	24.0	40.0	VDC
Set Point Voltage Tolerance	V_o tol		V_o≥5.0V	—	±1	±1.5	%V_o
			V_o≤3.3V	—	—	±50	mV
Temperature Variation	Reg_{temp}	–40° ≤T_a ≤ +85°C		—	±0.5	—	%V_o
Line Regulation	Reg_{line}	Over V_{in} range	V_o≥5.0V	—	±0.2	±1.0	%V_o
			V_o≤3.3V	—	±7	±33	mV
Load Regulation	Reg_{load}	Over I_o range	Vo ≥5.0V	—	±0.4	±1.0	%V_o
			V_o≤3.3V	—	±13	±33	mV
Total Output Voltage Variation	ΔV_otot	Includes set-point, line load,	V_o≥5.0V	—	±2	—	%V_o
		–40° ≤T_a ≤ +85°C	V_o≤3.3V	—	±67	—	mV
Efficiency	η		V_o = 15V V_o = 12V V_o =5.0V V_o =3.3V V_o =1.8V	— — — — —	86 83 82 78 67	— — — — —	%
V_o Ripple (pk-pk)	V_r	20MHz bandwidth	V_o ≥ 5.0V	—	0.5	—	%V_o
			V_o ≤ 3.3V	—	15	—	mV_{pp}
Transient Response	t_{tr}	0.1A/µs, load step 50% to 100% $I_o$max		—	100	—	µs
	ΔV_{tr}	V_o over/undershoot	V_o ≥ 5.0V	—	±3.0	—	%V_o
			V_o ≤ 3.3V	—	±150	—	mV
Short Circuit Current	I_{sc}			—	2x$I_o$max	—	A
Switching Frequency	f_s	Over V_{in} range	V_o ≥ 12.0V V_o ≤ 5.0V	600 800	650 850	700 900	kHz
Under-Voltage Lockout	UVLO			—	15	—	V
Remote On/Off (Pin 1) Input High Voltage Input Low Voltage	 V_{IH} V_{IL}	Referenced to –Vin (pin 2)		 2.5 –0.2	 — —	 7.0 (2) +0.8	V
Input Low Current	I_{IL}			—	–10	–	µA
Standby Input Current	I_{in} standby	pins 1 & 2 connected		—	7	50	mA
Internal Input Capacitance	C_{in}			—	1.0	—	µF
External Output Capacitance	C_{out}	Between +V_o and –V_o		0	—	200	µF
Isolation Voltage Capacitance Resistance		Input to output		1500 — 10	— 1100 —	— — —	V pF MΩ
Operating Temperature Range	T_a	Over V_{in} range		-40	—	+85 (3)	°C
Storage Temperature	T_s	—		-40	—	+125	°C
Reliability	MTBF	Per Bellcore TR-332 50% stress, T_a =40°C, ground benign		4.0	—	—	10^6 Hrs
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		—	15	—	G's
Weight	—	—		—	23	—	grams
Flammability	—	Materials meet UL 94V-0					

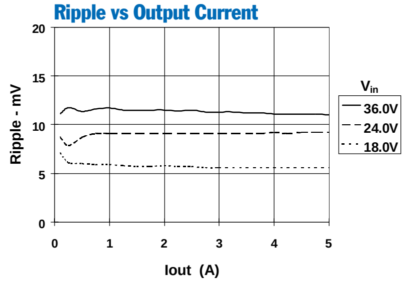
Notes: (1) *The DC/DC converter will operate at no load with reduced specifications.*
(2) *The Remote On/Off (pin 1) has an internal pull-up, and if it is left open circuit the module will operate when input power is applied. Refer to the application notes for interface considerations.*
(3) *See Safe Operating Area curves or contact the factory for the appropriate derating.*

PT4141, 3.3 VDC (See Note A)

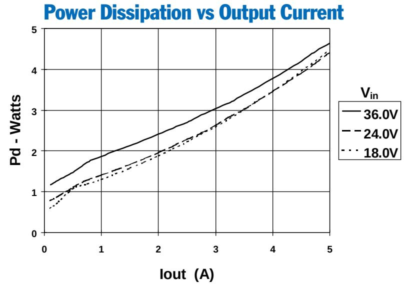
Efficiency vs Output Current



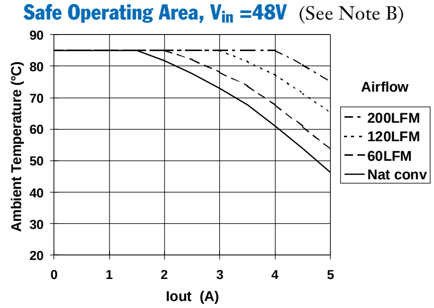
Ripple vs Output Current



Power Dissipation vs Output Current

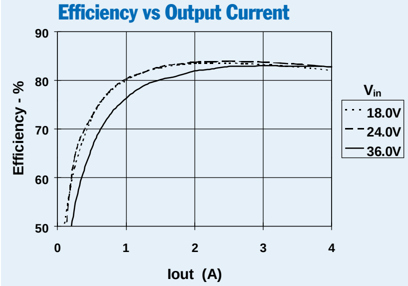


Safe Operating Area, V_{in} =48V (See Note B)

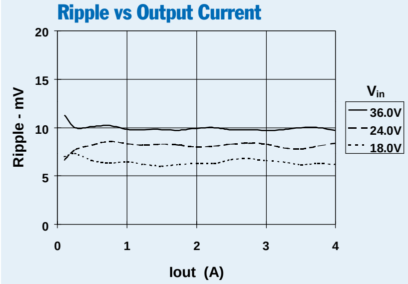


PT4142, 5.0 VDC (See Note A)

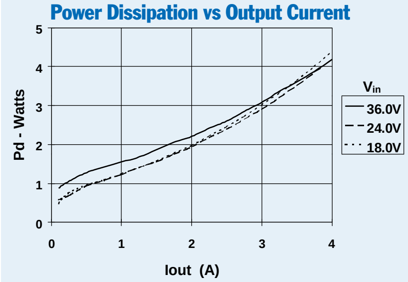
Efficiency vs Output Current



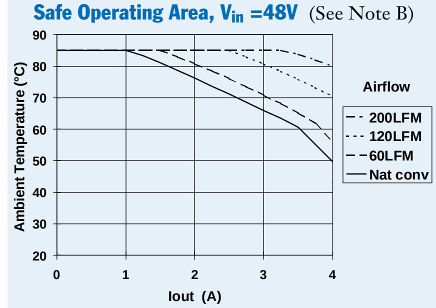
Ripple vs Output Current



Power Dissipation vs Output Current

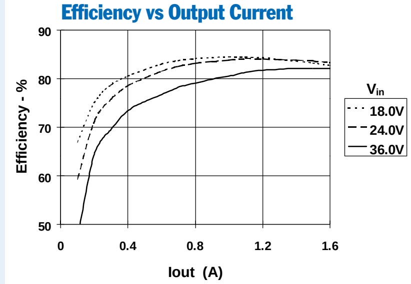


Safe Operating Area, V_{in} =48V (See Note B)

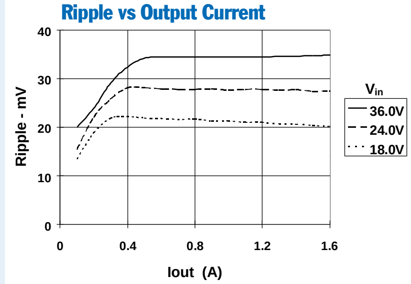


PT4143, 12.0 VDC (See Note A)

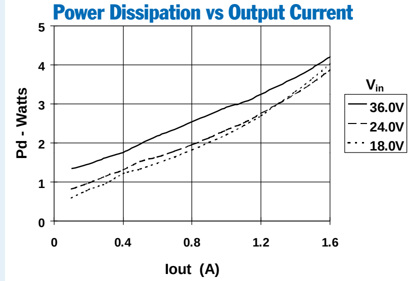
Efficiency vs Output Current



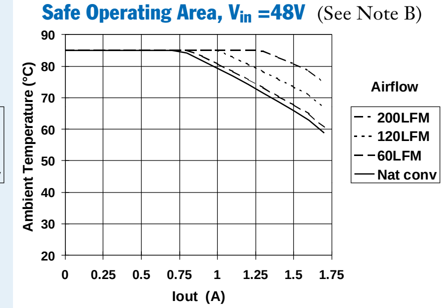
Ripple vs Output Current



Power Dissipation vs Output Current



Safe Operating Area, V_{in} =48V (See Note B)



Note A: *Characteristic data has been developed from actual products tested at 25°C. This data is considered typical data for the Converter.*
Note B: *SOA curves represent the conditions at which internal components are at or below the manufacturer's maximum operating temperatures*

Using the Remote On/Off Function on the PT4120/ PT4140 Series of Isolated DC/DC Converters

For applications requiring output voltage on/off control, the PT4120/4140 series of DC/DC converters incorporate a remote on/off function. This function may be used in applications that require battery conservation, power-up/ shutdown sequencing, and/or to co-ordinate the power-up of the regulator for active in-rush current control. (See the related application note, AN21).

This function is provided by the *Remote On/Off* control, pin1. If pin 1 is left open-circuit, the converter provides a regulated output whenever a valid source voltage[3] is applied between $+V_{in}$(pin 3), and $-V_{in}$ (pin 2). Applying a low-level ground signal [1] to pin 1 will disable the regulator output [5].

Table 1 provides details of the threshold requirements for the *Remote On/Off* pin. Figure 1 shows how a discrete MOSFET (Q_1) [4], may be referenced to the negative input voltage rail and used with this control input.

Table 1 Inhibit Control Thresholds

Parameter	min	max
Enable (V_{IH})	2.5V	(Open Circuit) [2,4]
Disable (V_{IL})	–0.3V	0.8V

Notes:

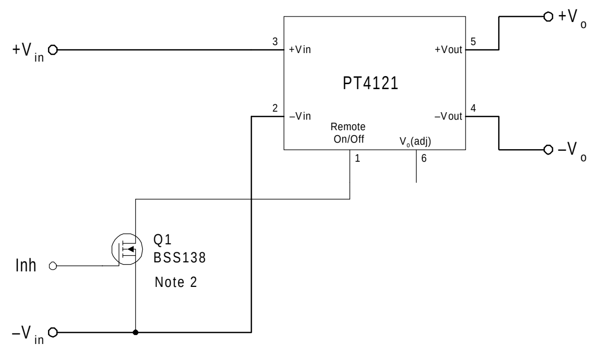
1. The on/off control uses $-V_{in}$ (pin 2), the primary side of the converter as its ground reference. All voltages specified are with respect to $-V_{in}$.
2. The on/off control internal circuitry is a high impedance 10µA current source. The open-circuit voltage may be as high as 8.3Vdc.
3. The PT4120/40 series incorporates 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

Series	UVLO Threshold	V_{in} Range
PT4120	31V Typical	36 – 75V
PT4140	15V Typical	18 – 40V

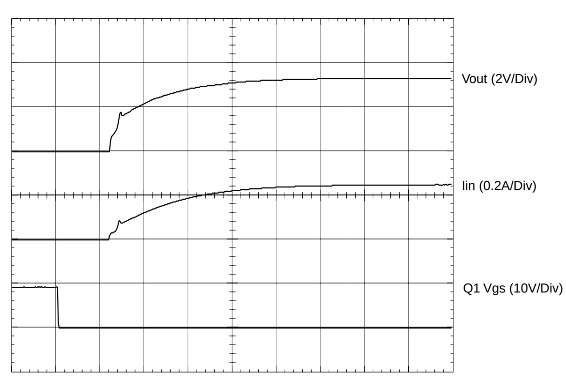
4. The *Remote On/Off* input of the PT4120/40 series regulators must be controlled with an open-collector (or open-drain) discrete transistor or MOSFET. *Do not* use a pull-up resistor.
5. When the converter output is disabled, the current drawn from the input supply is typically reduced to 8mA (16mA maximum).
6. 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: The converter typically produces a fully regulated output voltage within 50ms after the application of power, or the removal of the low voltage signal [6] from the *Remote On/Off* pin. 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 output voltage and input current waveforms of a PT4121 after Q_1 is turned off. The turn off of Q_1 corresponds to the drop in Q_1 V_{gs} voltage. The waveforms were measured with a 48Vdc input voltage, and 2.75-A resistive load.

Figure 2



Adjusting the Output Voltage of the PT4120/ PT4140 Series of Isolated DC/DC Converters

The factory pre-set output voltage of Power Trends' PT4120 and PT4140 series of isolated DC/DC converters may be adjusted within ±10% of nominal. Adjustment is made from the secondary side of the regulator[1] with 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, R_2 between pin 6 (V_o adjust), and pin 4 ($-V_{out}$).

Adjust Down: Add a resistor (R_1), between pin 6 (V_o adjust) and pin 5 ($+V_{out}$).

Refer to Figure 1 and Table 2 for both the placement and value of the required resistor, (R_1) or R_2.

Notes:

1. The PT4120 and PT4140 series of DC/DC converters incorporate isolation between the V_{in} and V_o terminals. Adjustment of the output voltage is made to the regulation circuit on the secondary or output side of the converter.
2. The maximum rated output power for this series is 20W. An increase in the output voltage may therefore require a corresponding reduction in the maximum output current (*see Table 1*). The revised maximum output current must be determined as follows:-

   $$I_o(max) = \frac{20}{V_a} \text{ A, or 5A, whichever is less.}$$

   Where V_a is the adjusted ouput voltage.
3. Use only a single 1% resistor in either the (R_1) or R_2 location. Place the resistor as close to the ISR as possible.
4. Never connect capacitors to V_o adjust. Any capacitance added to the V_o adjust control pin will affect the stability of the ISR.

The values of (R_1) [adjust down], and R_2 [adjust up], can also be calculated using the following formulas.

$$(R_1) = \frac{K_o (V_a - V_r)}{V_r (V_o - V_a)} - R_s \quad k\Omega$$

$$R_2 = \frac{K_o}{(V_a - V_o)} - R_s \quad k\Omega$$

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 = Internal series resistance (Table 1)

Figure 1

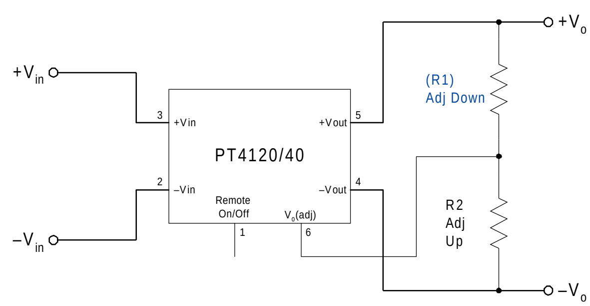


Table 1

DC/DC CONVERTER ADJUSTMENT RANGE AND FORMULA PARAMETERS

Series Pt #									
48V Bus	**PT4126**	**PT4129**	**PT4127**	**PT4128**	**PT4121**	**PT4122**	**PT4125**	**PT4123**	**PT4124**
24V Bus	**PT4146**		**PT4147**	**PT4148**	**PT4141**	**PT4142**		**PT4143**	**PT4144**
Max Current [2]	**5A**	**5A**	**5A**	**5A**	**5A**	**4A**	**3.8A**	**1.6A**	**1.3A**
V_o(nom)	1.5	1.65	1.8	2.5	3.3	5.0	5.2V	12.0	15.0
Va(min)	1.35	1.49	1.62	2.25	2.95	4.5	4.75	10.8	13.5
Va(max)	1.65	1.81	1.98	2.75	3.65	5.5	5.75	13.2	16.5
V_r	1.225	1.225	1.225	1.225	1.225	2.5	2.5	2.5	2.5
K_o (V·kΩ)	67.07	63.9	69.7	64.2	69.3	125.2	134.7	139.8	137.6
R_s (kΩ)	43.2	66.5	110.0	187.0	187.0	187.0	243.0	110.0	90.9

Table 2

DC/DC CONVERTER SERIES ADJUSTMENT RESISTOR VALUES

Series Pt #				
48V Bus	**PT4126**	**PT4127**	**PT4128**	**PT4121**
24V Bus	**PT4146**	**PT4147**	**PT4148**	**PT4141**
V_o(nom)	**1.5Vdc**	**1.8Vdc**	**2.5Vdc**	**3.3Vdc**
V_a(req'd)				
1.35	(2.8)kΩ			
1.4	(53.2)kΩ			
1.45	(204.0)kΩ			
1.5				
1.55	1.3MΩ			
1.6	627.0kΩ			
1.65	404.0kΩ	(51.7)kΩ		
1.7		(161.0)kΩ		
1.75		(489.0)kΩ		
1.8				
1.85		1.28MΩ		
1.9		587.0kΩ		
1.95		355.0kΩ		
2.25			(26.5)kΩ	
2.3			(92.9)kΩ	
2.35			(203.0)kΩ	
2.4			(425.0)kΩ	
2.45			(1.09)MΩ	
2.5				
2.55			1.09MΩ	
2.6			450.0kΩ	
2.65			237.0kΩ	
2.7			131.0kΩ	
2.75			67.7kΩ	
2.95				(90.7)kΩ
3.0				(146.0)kΩ
3.05				(224.0)kΩ
3.1				(341.0)kΩ
3.15				(536.0)kΩ
3.2				(926.0)kΩ
3.25				(2.09)MΩ
3.3				
3.35				1.19MΩ
3.4				502.0kΩ
3.45				272.0kΩ
3.5				158.0kΩ
3.55				88.7kΩ
3.6				42.7kΩ
3.65				9.9kΩ

	PT4122
	PT4142
	5.0Vdc
V_a(req'd)	
4.5	(12.6)kΩ
4.55	(40.3)kΩ
4.6	(75.0)kΩ
4.65	(120.0)kΩ
4.7	(179.0)kΩ
4.75	(262.0)kΩ
4.8	(387.0)kΩ
4.85	(595.0)kΩ
4.9	(1.01)MΩ
4.95	
5.0	
5.05	
5.1	1.06MΩ
5.15	645.0kΩ
5.2	437.0kΩ
5.25	312.0kΩ
5.3	229.0kΩ
5.35	169.0kΩ
5.4	125.0kΩ
5.45	90.2kΩ
5.5	62.4kΩ

	PT4123	**PT4124**
	PT4143	**PT4144**
	12.0Vdc	**15.0Vdc**
V_a(req'd)		
10.8	(276.0)kΩ	
11.0	(365.0)kΩ	
11.2	(497.0)kΩ	
11.4	(719.0)kΩ	
11.6	(1.16)MΩ	
11.8		
12.0		
12.2	588.0kΩ	
12.4	239.0kΩ	
12.6	123.0kΩ	
12.8	64.6kΩ	
13.0	29.7kΩ	
13.2	6.4kΩ	
13.5		(312.0)kΩ
13.6		(345.0)kΩ
13.8		(427.0)kΩ
14.0		(542.0)kΩ
14.2		(713.0)kΩ
14.4		(1.0)MΩ
14.6		(1.57)MΩ
14.8		
15.0		
15.2		597.0kΩ
15.4		253.0kΩ
15.6		138.0kΩ
15.8		81.0kΩ
16.0		46.6kΩ
16.5		0.8kΩ

R_1 = (Blue) R_2 = Black

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