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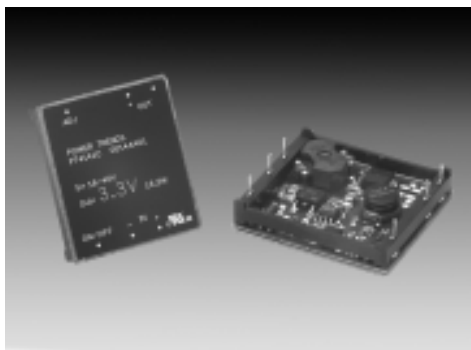
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## PT4140 Series

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
- 4x10<sup>6</sup> 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  $\pm 10\%$  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

<b>PT4141</b>	=	3.3V/5A	(16.5W)
<b>PT4142</b>	=	5.0V/4A	
<b>PT4143</b>	=	12.0V/1.6A	
<b>PT4144</b>	=	15.0V/1.3A	
<b>PT4146</b>	=	1.5V/5A	(7.5W)
<b>PT4147</b>	=	1.8V/5A	(9W)
<b>PT4148</b>	=	2.5V/5A	(12.5W)

### Pin-Out Information

Pin	Function
1	Remote On/Off †
2	-V <sub>IN</sub>
3	+V <sub>IN</sub>
4	-V <sub>OUT</sub>
5	+V <sub>OUT</sub>
6	V <sub>OUT</sub> Adjust †

† For further information, see application notes.

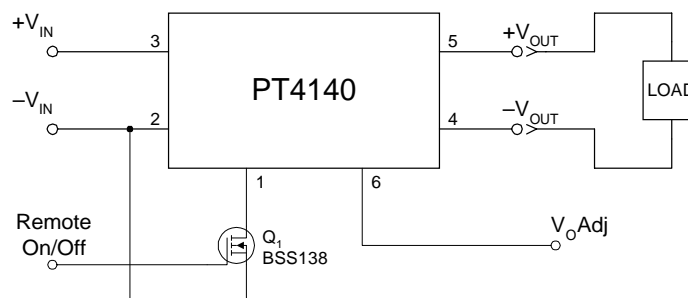
### PT Series Suffix (PT1234x)

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

\* Previously known as package style 710.

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

### Standard Application



## PT4140 Series

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

### Specifications (Unless otherwise stated, $T_a = 25^\circ\text{C}$ , $V_{in} = 24\text{V}$ , $C_{out} = 0\mu\text{F}$ , and $I_o = I_{o\text{max}}$ )

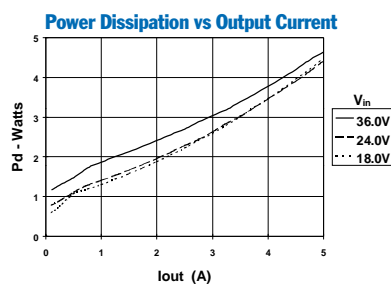
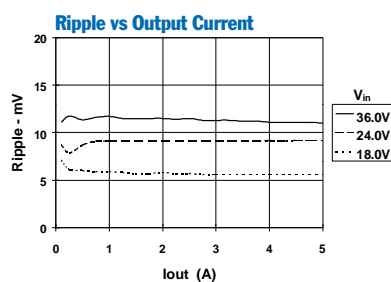
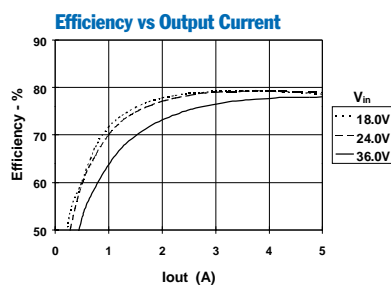
Characteristic	Symbol	Conditions	PT4140 SERIES			Units
			Min	Typ	Max	
Output Current	$I_o$	Over $V_{in}$ range $V_o = 15\text{V}$ $V_o = 12\text{V}$ $V_o = 5.0\text{V}$ $V_o \leq 3.3\text{V}$	0.1 (1) 0.1 (1) 0.1 (1) 0.1 (1)	— — — —	1.3 1.6 4.0 5.0	A
Input Voltage Range	$V_{in}$	Over $I_o$ Range	18.0	24.0	40.0	VDC
Set Point Voltage Tolerance	$V_o \text{ tol}$	$V_o \geq 5.0\text{V}$ $V_o \leq 3.3\text{V}$	— —	$\pm 1$ —	$\pm 1.5$ $\pm 50$	$\%V_o$ mV
Temperature Variation	$\text{Reg}_{\text{temp}}$	$-40^\circ \leq T_a \leq +85^\circ\text{C}$	—	$\pm 0.5$	—	$\%V_o$
Line Regulation	$\text{Reg}_{\text{line}}$	Over $V_{in}$ range $V_o \geq 5.0\text{V}$ $V_o \leq 3.3\text{V}$	— —	$\pm 0.2$ $\pm 7$	$\pm 1.0$ $\pm 33$	$\%V_o$ mV
Load Regulation	$\text{Reg}_{\text{load}}$	Over $I_o$ range $V_o \geq 5.0\text{V}$ $V_o \leq 3.3\text{V}$	— —	$\pm 0.4$ $\pm 13$	$\pm 1.0$ $\pm 33$	$\%V_o$ mV
Total Output Voltage Variation	$\Delta V_{o\text{tot}}$	Includes set-point, line load, $-40^\circ \leq T_a \leq +85^\circ\text{C}$ $V_o \geq 5.0\text{V}$ $V_o \leq 3.3\text{V}$	— —	$\pm 2$ $\pm 67$	— —	$\%V_o$ mV
Efficiency	$\eta$	$V_o = 15\text{V}$ $V_o = 12\text{V}$ $V_o = 5.0\text{V}$ $V_o = 3.3\text{V}$ $V_o = 1.8\text{V}$	— — — — —	86 83 82 78 67	— — — — —	%
$V_o$ Ripple (pk-pk)	$V_r$	20MHz bandwidth $V_o \geq 5.0\text{V}$ $V_o \leq 3.3\text{V}$	— —	0.5 15	— —	$\%V_o$ mV <sub>pp</sub>
Transient Response	$t_{tr}$ $\Delta V_{tr}$	0.1A/ $\mu\text{s}$ , load step 50% to 100% $I_{o\text{max}}$ $V_o$ over/undershoot $V_o \geq 5.0\text{V}$ $V_o \leq 3.3\text{V}$	— — —	100 $\pm 3.0$ $\pm 150$	— — —	$\mu\text{s}$ $\%V_o$ mV
Short Circuit Current	$I_{sc}$		—	$2 \times I_{o\text{max}}$	—	A
Switching Frequency	$f_s$	Over $V_{in}$ range $V_o \geq 12.0\text{V}$ $V_o \leq 5.0\text{V}$	600 800	650 850	700 900	kHz
Under-Voltage Lockout	UVLO		—	15	—	V
Remote On/Off (Pin 1)	$V_{IH}$ $V_{IL}$ $I_{IL}$	Referenced to $-V_{in}$ (pin 2)	2.5 -0.2 —	— — -10	7.0 (2) +0.8 —	V $\mu\text{A}$
Standby Input Current	$I_{in \text{ standby}}$	pins 1 & 2 connected	—	7	50	mA
Internal Input Capacitance	$C_{in}$		—	1.0	—	$\mu\text{F}$
External Output Capacitance	$C_{out}$	Between $+V_o$ and $-V_o$	0	—	200	$\mu\text{F}$
Isolation Voltage		Input to output	1500	—	—	V
Capacitance			—	1100	—	pF
Resistance			10	—	—	M $\Omega$
Operating Temperature Range	$T_a$	Over $V_{in}$ range	-40	—	+85 (3)	$^\circ\text{C}$
Storage Temperature	$T_s$	—	-40	—	+125	$^\circ\text{C}$
Reliability	MTBF	Per Bellcore TR-332 50% stress, $T_a = 40^\circ\text{C}$ , ground benign	4.0	—	—	10 <sup>6</sup> 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.

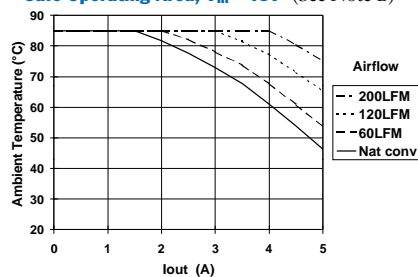
## PT4140 Series

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

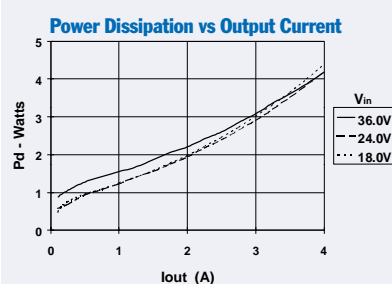
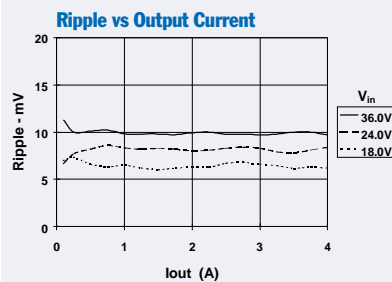
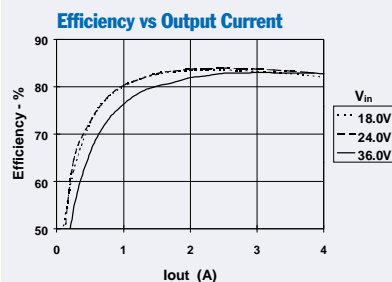
**PT4141, 3.3 VDC** (See Note A)



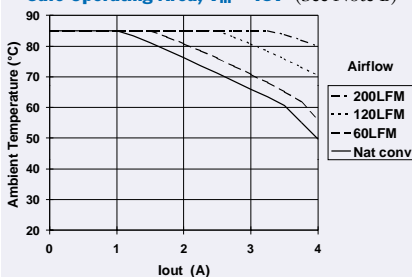
**Safe Operating Area,  $V_{in} = 48V$**  (See Note B)



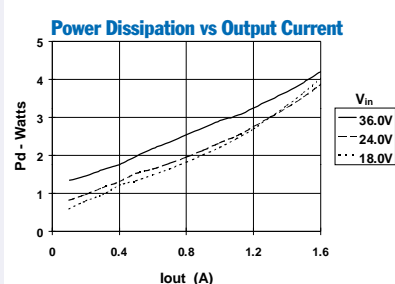
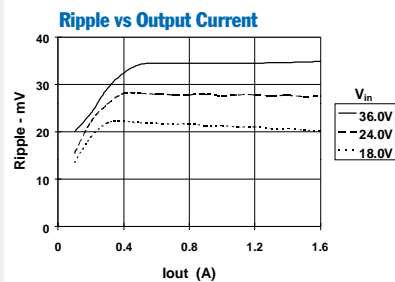
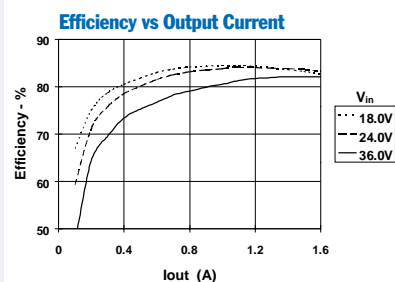
**PT4142, 5.0 VDC** (See Note A)



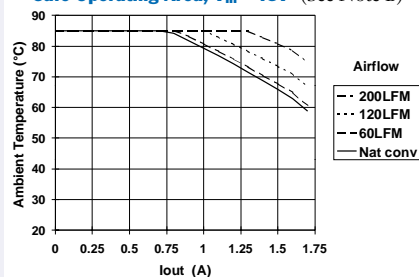
**Safe Operating Area,  $V_{in} = 48V$**  (See Note B)



**PT4143, 12.0 VDC** (See Note A)



**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

## Application Notes

### PT4120/4140 Series

#### 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, pin 1. If pin 1 is left open-circuit, the converter provides a regulated output whenever a valid source voltage<sup>3</sup> is applied between  $+V_{in}$  (pin 3), and  $-V_{in}$  (pin 2). Applying a low-level ground signal<sup>1</sup> to pin 1 will disable the regulator output<sup>5</sup>.

Table 1 provides details of the threshold requirements for the *Remote On/Off* pin. Figure 1 shows how a discrete MOSFET ( $Q_1$ ), 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) <sup>2,4</sup>
Disable ( $V_{IL}$ )	-0.3V	0.8V

#### Notes:

- 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  $-V_{in}$ .
- The on/off control internal circuitry is a high impedance  $10\mu A$  current source. The open-circuit voltage may be as high as 8.3Vdc.
- 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.

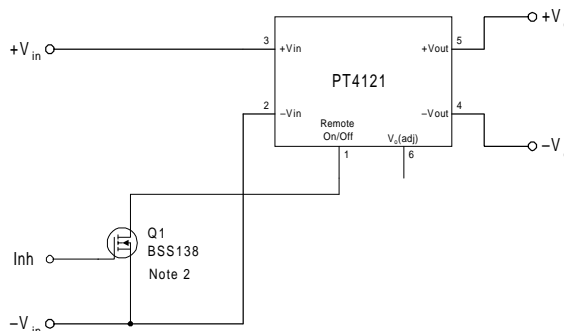
**Table 2 UVLO Thresholds**

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

- 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.
- When the converter output is disabled, the current drawn from the input supply is typically reduced to 8mA (16mA maximum).

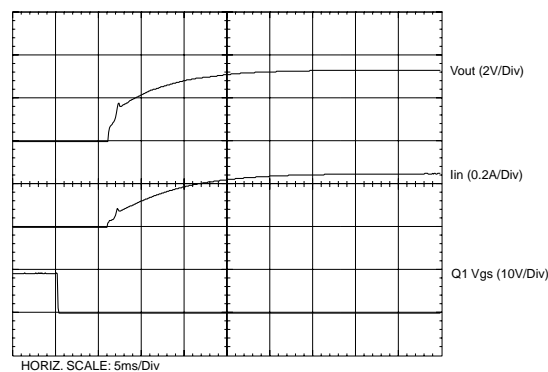
- Keep the on/off transition to less than 1ms. This prevents erratic operation of the ISR, whereby the output voltage may drift un-regulated between 0V and the rated output during power-up.

**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<sup>6</sup> 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**



## Application Notes

### PT4120/4140 Series

#### 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  $\pm 10\%$  of nominal. Adjustment is made from the secondary side of the regulator<sup>1</sup> 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:

- 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.
- 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:-

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

Where  $V_a$  is the adjusted output voltage.

- 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.

- Never connect capacitors to  $V_o$  adjust. Any capacitance added to the  $V_o$  adjust control pin will affect the stability of the ISR.

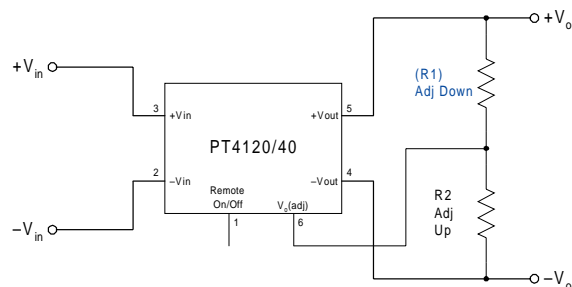
The values of ( $R_1$ ) [adjust down], and  $R_2$  [adjust up], can also be calculated using the following formulas.

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

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

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
$V_a$ (min)	1.35	1.49	1.62	2.25	2.95	4.5	4.75	10.8	13.5
$V_a$ (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-k $\Omega$ )	67.07	63.9	69.7	64.2	69.3	125.2	134.7	139.8	137.6
$R_s$ (k $\Omega$ )	43.2	66.5	110.0	187.0	187.0	187.0	243.0	110.0	90.9

## Application Notes continued

### PT4120/4140 Series

**Table 2**

**DC/DC CONVERTER SERIES ADJUSTMENT RESISTOR VALUES**

Series Pt #								
48V Bus	PT4126	PT4127	PT4128	PT4121	PT4122		PT4123	PT4124
24V Bus	PT4146	PT4147	PT4148	PT4141	PT4142		PT4143	PT4144
V <sub>o</sub> (nom)	1.5Vdc	1.8Vdc	2.5Vdc	3.3Vdc	5.0Vdc		12.0Vdc	15.0Vdc
V <sub>a</sub> (req'd)					V <sub>a</sub> (req'd)		V <sub>a</sub> (req'd)	
1.35	(2.8)kΩ				4.5	(12.6)kΩ	10.8	(276.0)kΩ
1.4	(53.2)kΩ				4.55	(40.3)kΩ	11.0	(365.0)kΩ
1.45	(204.0)kΩ				4.6	(75.0)kΩ	11.2	(497.0)kΩ
1.5					4.65	(120.0)kΩ	11.4	(719.0)kΩ
1.55	1.3MΩ				4.7	(179.0)kΩ	11.6	(1.16)MΩ
1.6	627.0kΩ				4.75	(262.0)kΩ	11.8	
1.65	404.0kΩ	(51.7)kΩ			4.8	(387.0)kΩ	12.0	
1.7		(161.0)kΩ			4.85	(595.0)kΩ	12.2	588.0kΩ
1.75		(489.0)kΩ			4.9	(1.01)MΩ	12.4	239.0kΩ
1.8					4.95		12.6	123.0kΩ
1.85		1.28MΩ			5.0		12.8	64.6kΩ
1.9		587.0kΩ			5.05		13.0	29.7kΩ
1.95		355.0kΩ			5.1	1.06MΩ	13.2	6.4kΩ
2.25			(26.5)kΩ		5.15	645.0kΩ	13.5	(312.0)kΩ
2.3			(92.9)kΩ		5.2	437.0kΩ	13.6	(345.0)kΩ
2.35			(203.0)kΩ		5.25	312.0kΩ	13.8	(427.0)kΩ
2.4			(425.0)kΩ		5.3	229.0kΩ	14.0	(542.0)kΩ
2.45			(1.09)MΩ		5.35	169.0kΩ	14.2	(713.0)kΩ
2.5					5.4	125.0kΩ	14.4	(1.0)MΩ
2.55			1.09MΩ		5.45	90.2kΩ	14.6	(1.57)MΩ
2.6			450.0kΩ		5.5	62.4kΩ	14.8	
2.65			237.0kΩ				15.0	
2.7			131.0kΩ				15.2	597.0kΩ
2.75			67.7kΩ				15.4	253.0kΩ
2.95				(90.7)kΩ			15.6	138.0kΩ
3.0				(146.0)kΩ			15.8	81.0kΩ
3.05				(224.0)kΩ			16.0	46.6kΩ
3.1				(341.0)kΩ			16.5	0.8kΩ
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				

R<sub>1</sub> = (Blue)      R<sub>2</sub> = Black

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