

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
- 4x10⁶ 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) |

Pin-Out Information

| Pin | Function |
|-----|---------------------------|
| 1 | Remote On/Off † |
| 2 | -V _{IN} |
| 3 | +V _{IN} |
| 4 | -V _{OUT} |
| 5 | +V _{OUT} |
| 6 | V _{OUT} Adjust † |

† For further information, see application notes.

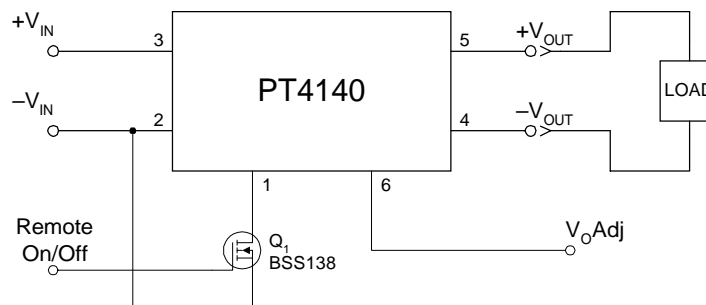
PT Series Suffix (PT1234x)

| 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)

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 $I_o = I_{o,max}$)

| Characteristic | Symbol | Conditions | PT4140 SERIES | | | Units | |
|--------------------------------|---------------------|---|-------------------------|----------------------|--------------------|------------------|------------------|
| | | | Min | Typ | Max | | |
| Output Current | I_o | Over V_{in} range | $V_o = 15\text{V}$ | 0.1 ⁽¹⁾ | — | 1.3 | A |
| | | | $V_o = 12\text{V}$ | 0.1 ⁽¹⁾ | — | 1.6 | |
| | | | $V_o = 5.0\text{V}$ | 0.1 ⁽¹⁾ | — | 4.0 | |
| | | | $V_o \leq 3.3\text{V}$ | 0.1 ⁽¹⁾ | — | 5.0 | |
| Input Voltage Range | V_{in} | Over I_o Range | 18.0 | 24.0 | 40.0 | VDC | |
| Set Point Voltage Tolerance | $V_o\text{tol}$ | | $V_o \geq 5.0\text{V}$ | — | ± 1 | ± 1.5 | $\%V_o$ |
| | | | $V_o \leq 3.3\text{V}$ | — | — | ± 50 | mV |
| Temperature Variation | Reg_{temp} | $-40^\circ \leq T_a \leq +85^\circ\text{C}$ | — | ± 0.5 | — | $\%V_o$ | |
| Line Regulation | Reg_{line} | Over V_{in} range | $V_o \geq 5.0\text{V}$ | — | ± 0.2 | ± 1.0 | $\%V_o$ |
| | | | $V_o \leq 3.3\text{V}$ | — | ± 7 | ± 33 | mV |
| Load Regulation | Reg_{load} | Over I_o range | $V_o \geq 5.0\text{V}$ | — | ± 0.4 | ± 1.0 | $\%V_o$ |
| | | | $V_o \leq 3.3\text{V}$ | — | ± 13 | ± 33 | mV |
| Total Output Voltage Variation | $\Delta V_{o,tot}$ | Includes set-point, line load, $-40^\circ \leq T_a \leq +85^\circ\text{C}$ | $V_o \geq 5.0\text{V}$ | — | ± 2 | — | $\%V_o$ |
| | | | $V_o \leq 3.3\text{V}$ | — | ± 67 | — | mV |
| Efficiency | η | | $V_o = 15\text{V}$ | — | 86 | — | % |
| | | | $V_o = 12\text{V}$ | — | 83 | — | |
| | | | $V_o = 5.0\text{V}$ | — | 82 | — | |
| | | | $V_o = 3.3\text{V}$ | — | 78 | — | |
| | | | $V_o = 1.8\text{V}$ | — | 67 | — | |
| V_o Ripple (pk-pk) | V_r | 20MHz bandwidth | $V_o \geq 5.0\text{V}$ | — | 0.5 | — | $\%V_o$ |
| | | | $V_o \leq 3.3\text{V}$ | — | 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 | $V_o \geq 5.0\text{V}$ | — | ± 3.0 | — | $\%V_o$ |
| | | | $V_o \leq 3.3\text{V}$ | — | ± 150 | — | mV |
| Short Circuit Current | I_{sc} | | — | $2 \times I_{o,max}$ | — | A | |
| Switching Frequency | f_s | Over V_{in} range | $V_o \geq 12.0\text{V}$ | 600 | 650 | 700 | kHz |
| | | | $V_o \leq 5.0\text{V}$ | 800 | 850 | 900 | |
| Under-Voltage Lockout | UVLO | | — | 15 | — | V | |
| Remote On/Off (Pin 1) | | Referenced to $-V_{in}$ (pin 2) | | | | | |
| Input High Voltage | V_{IH} | | 2.5 | — | 7.0 ⁽²⁾ | V | |
| Input Low Voltage | V_{IL} | | -0.2 | — | +0.8 | | |
| 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 | | Input to output | 1500 | — | — | V | |
| | | | — | 1100 | — | pF | |
| Capacitance | | | 10 | — | — | M Ω | |
| Resistance | | | | | | | |
| 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 | — | — | 10^6 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.

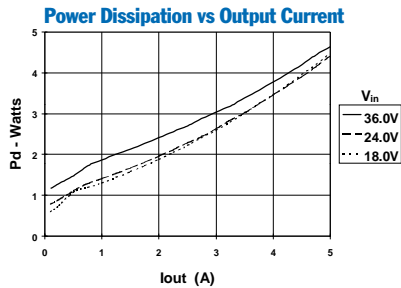
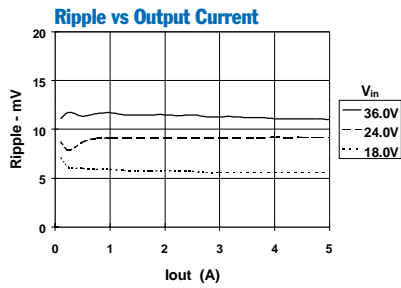
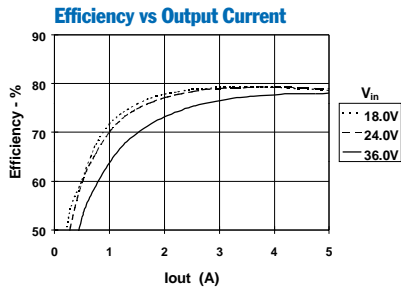
(2) The Remote On/Off (pin 1) has an internal pull-up, and if it is left open circuit the module will operate when input power is applied. Refer to the application notes for interface considerations.

(3) See Safe Operating Area curves or contact the factory for the appropriate derating.

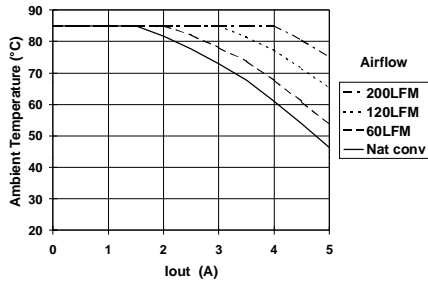
PT4140 Series

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

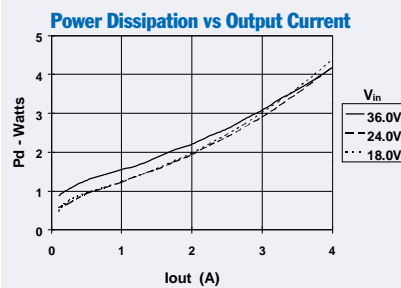
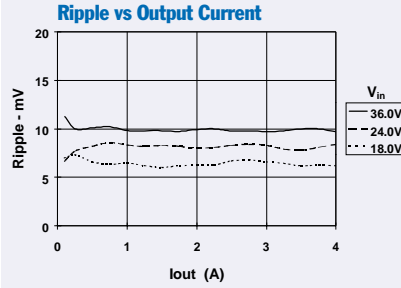
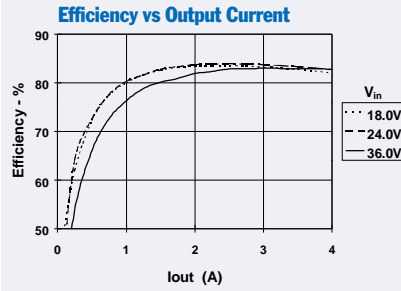
PT4141, 3.3 VDC (See Note A)



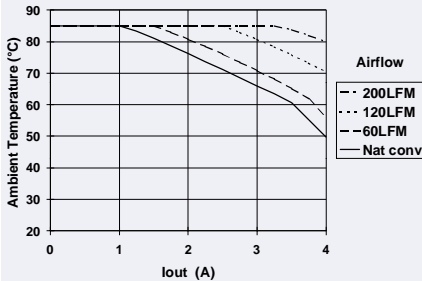
Safe Operating Area, $V_{in} = 24V$ (See Note B)



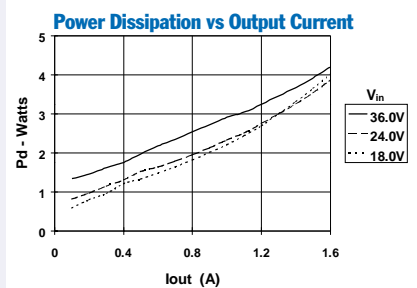
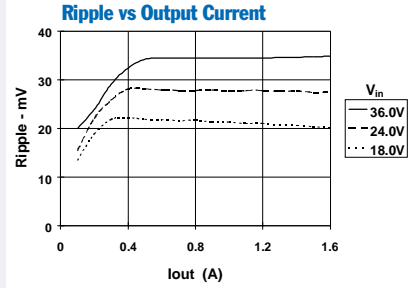
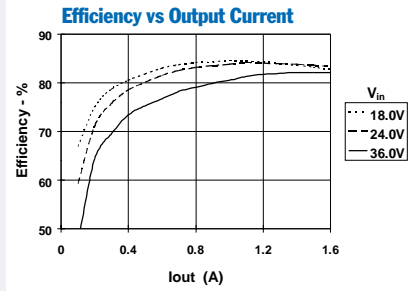
PT4142, 5.0 VDC (See Note A)



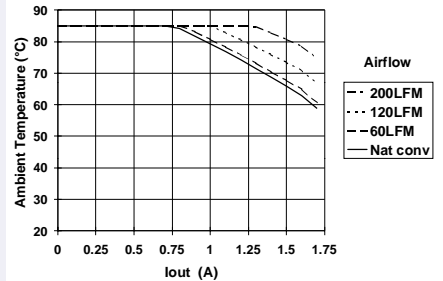
Safe Operating Area, $V_{in} = 24V$ (See Note B)



PT4143, 12.0 VDC (See Note A)



Safe Operating Area, $V_{in} = 24V$ (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 voltage³ is applied between +V_{in}(pin 3), and -V_{in} (pin 2). Applying a low-level ground signal¹ to pin 1 will disable the regulator output⁵.

Table 1 provides details of the threshold requirements for the *Remote On/Off* pin. Figure 1 shows how a discrete MOSFET (Q₁)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.

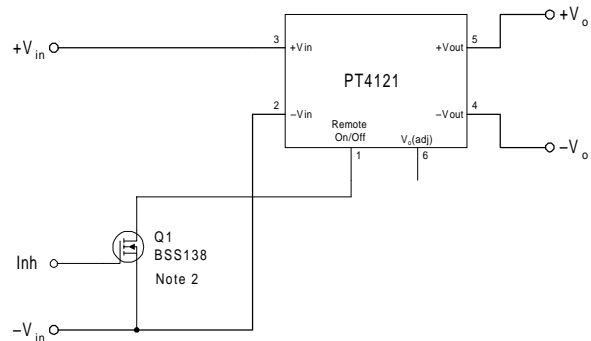
Table 2 UVLO Thresholds

| Series | UVLO Threshold | V _m 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).

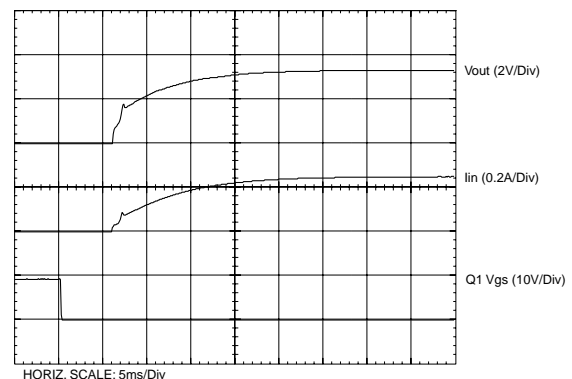
6. Keep the on/off transition to less than 1ms. This prevents erratic operation of the ISR, whereby the output voltage may drift un-regulated between 0V and the rated output during power-up.

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 signal⁶ 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 Q₁ is turned off. The turn off of Q₁ corresponds to the drop in Q₁ 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 $\pm 10\%$ of nominal. Adjustment is made from the secondary side of the regulator¹ 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

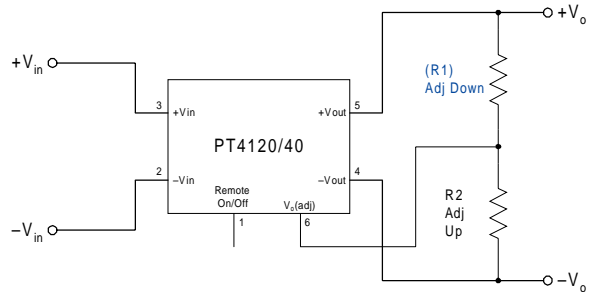


Table 1

DC/DC CONVERTER ADJUSTMENT RANGE AND FORMULA PARAMETERS

| Series Pt # | PT4126 | PT4129 | PT4127 | PT4128 | PT4121 | PT4122 | PT4125 | PT4123 | PT4124 |
|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 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 Ω) | 67.07 | 63.9 | 69.7 | 64.2 | 69.3 | 125.2 | 134.7 | 139.8 | 137.6 |
| R_s (k Ω) | 43.2 | 66.5 | 110.0 | 187.0 | 187.0 | 187.0 | 243.0 | 110.0 | 90.9 |

PT4120/4140 Series

Table 2

DC/DC CONVERTER SERIES ADJUSTMENT RESISTOR VALUES

| Series Pt # | 48V Bus | | | | 24V Bus | | 12.0Vdc | | 15.0Vdc | |
|------------------------|------------------------|-----------|-----------|-----------|------------------------|-----------|------------------------|-----------|------------------------|--------|
| | PT4126 | PT4127 | PT4128 | PT4121 | PT4122 | PT4142 | PT4123 | PT4124 | PT4143 | PT4144 |
| V _o (nom) | 1.5Vdc | 1.8Vdc | 2.5Vdc | 3.3Vdc | 5.0Vdc | | 12.0Vdc | 15.0Vdc | | |
| V _a (req'd) | V _a (req'd) | | | | V _a (req'd) | | V _a (req'd) | | V _a (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 | | | | | | |

R₁ = (Blue) R₂ = Black



PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| PT4141A | ACTIVE | DIP MOD ULE | EGD | 6 | 16 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT4141C | ACTIVE | DIP MOD ULE | EGE | 6 | 16 | Pb-Free (RoHS) | Call TI | Level-1-215C-UNLIM |
| PT4142A | ACTIVE | DIP MOD ULE | EGD | 6 | 16 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT4142C | ACTIVE | DIP MOD ULE | EGE | 6 | 16 | Pb-Free (RoHS) | Call TI | Level-1-215C-UNLIM |
| PT4143A | ACTIVE | DIP MOD ULE | EGD | 6 | 16 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT4143C | ACTIVE | DIP MOD ULE | EGE | 6 | 16 | Pb-Free (RoHS) | Call TI | Level-1-215C-UNLIM |
| PT4144A | ACTIVE | DIP MOD ULE | EGD | 6 | 16 | Pb-Free (RoHS) | Call TI | N / A for Pkg Type |
| PT4144C | ACTIVE | DIP MOD ULE | EGE | 6 | 16 | Pb-Free (RoHS) | Call TI | Level-1-215C-UNLIM |
| PT4146C | ACTIVE | DIP MOD ULE | EGE | 6 | 16 | Pb-Free (RoHS) | Call TI | Level-1-215C-UNLIM |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSELETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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