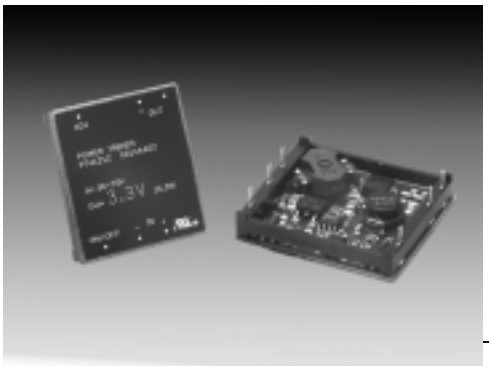
PT4120 Series

20-W 48-V Input Isolated DC/DC Converter

SLTS092B

(Revised 2/26/2002)



Features

- Input Voltage Range: 36V to 75V
- 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
- 4×10⁶ Hrs MTBF

Description

The PT4120 power modules are a series of isolated DC/DC converters housed 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 ±10% of nominal. These converters are ideal for Telecom, Industrial, Computer, and other distributed power applications that require input-to-output isolation.

Using multiple PT4120 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 PT4120 series requires no additional components for proper operation.

Ordering Information

PT4121❒	=	3.3V/5A	(16.5W)
PT4122❒	=	5.0V/4A	
PT4123❒	=	12.0V/1·6A	
PT4124❒	=	15.0V/1·3A	
PT4125❒	=	5.2V/3·8A	
PT4126❒	=	1.5V/5A	(7.5W)
PT4127❒	=	1.8V/5A	(9W)
PT4128❒	=	2.5V/5A	(12.5W)
PT4129❒	=	1.65V/5A	(8·25W)

PT Series Suffix (PT1234x)

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

** Previously known as package style 710.*

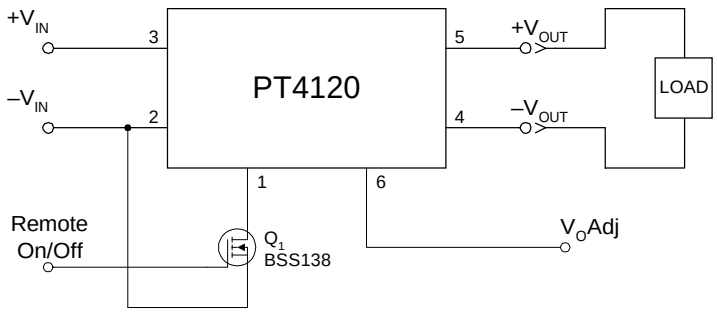
(Reference the applicable package code drawing for the dimensions and PC board layout)

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} =48V, C_{out} =0µF, and I_o =$I_o$max)

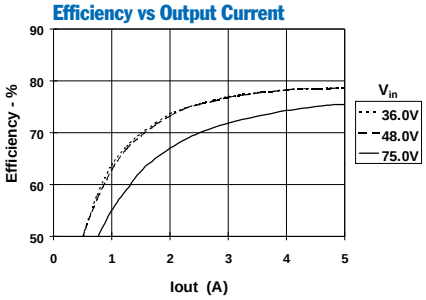
Characteristic	Symbol	Conditions		PT4120 SERIES Min	Typ	Max	Units
Output Current	I_o	Over V_{in} range	V_o = 15V V_o =12V V_o =5.0V V_o ≤3.3V	0.1 (1) 0.1 (1) 0.1 (1) 0.1 (1)	— — — —	1.3 1.6 4.0 5.0	A
Input Voltage Range	V_{in}	Over I_o Range		36.0	48.0	75.0	VDC
Set Point Voltage Tolerance	V_o tol		V_o≥5.0V	—	±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 ≤ 5.2V	600 800	650 850	700 900	kHz
Under-Voltage Lockout	UVLO			—	31	—	V
Remote On/Off (Pin 1) Input High Voltage Input Low Voltage Input Low Current	 V_{IH} V_{IL} I_{IL}	Referenced to –Vin (pin 2)		 2.5 –0.2 —	 — — –10	 7.0 (2) +0.8 –	 V µA
Standby Input Current	I_{in} standby	pins 1 & 2 connected		—	7	50	mA
Internal Input Capacitance	C_{in}			—	0.5	—	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 PT4120 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.

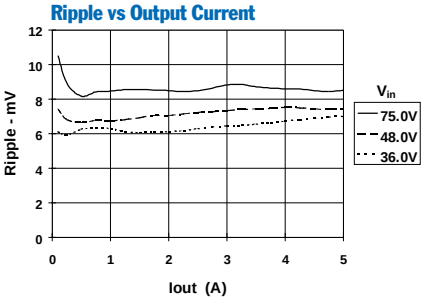
Typical Characteristics

PT4121, 3.3 VDC (See Note A)

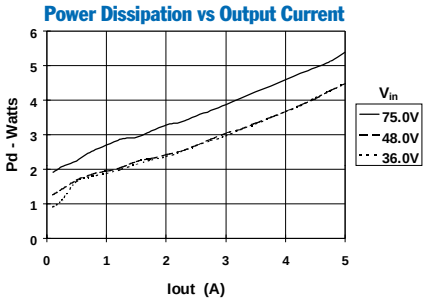
Efficiency vs Output Current



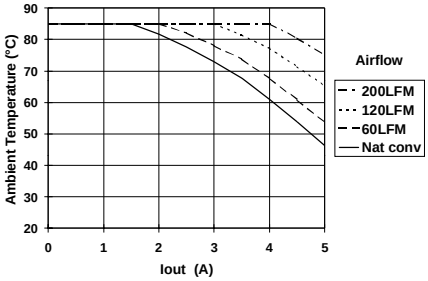
Ripple vs Output Current



Power Dissipation vs Output Current

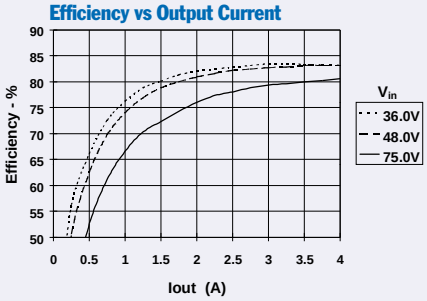


Safe Operating Area, V_{in} =48V (See Note B)

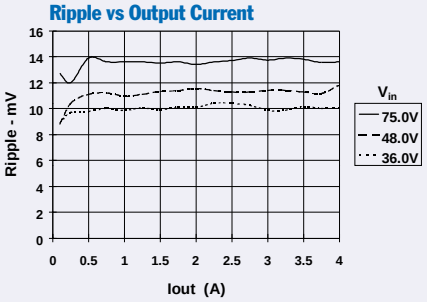


PT4122, 5.0 VDC (See Note A)

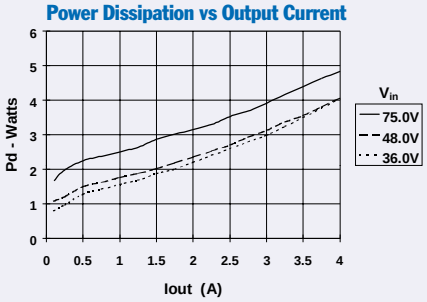
Efficiency vs Output Current



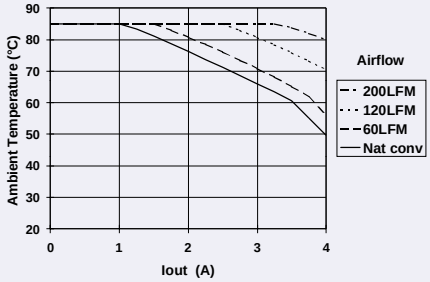
Ripple vs Output Current



Power Dissipation vs Output Current

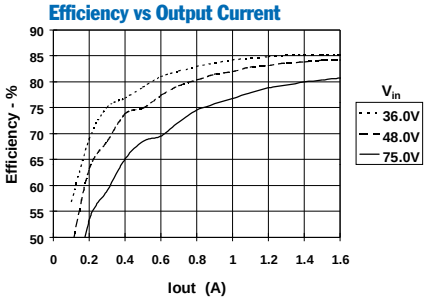


Safe Operating Area, V_{in} =48V (See Note B)

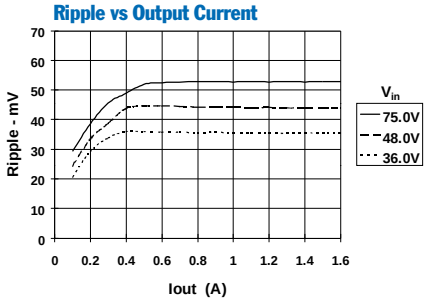


PT4123, 12.0 VDC (See Note A)

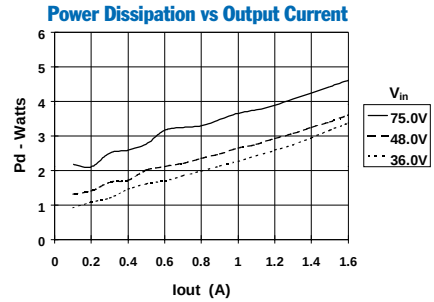
Efficiency vs Output Current



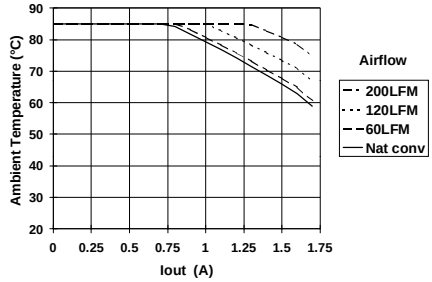
Ripple vs Output Current



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:

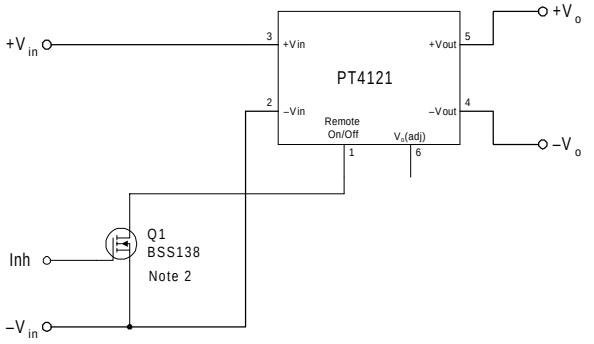
1. The on/off control uses -V_{in} (pin 2), the primary side of the converter as its ground reference. All voltages specified are with respect to -V_{in}.
2. The on/off control internal circuitry is a high impedance 10µA current source. The open-circuit voltage may be as high as 8.3Vdc.
3. The PT4120/40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

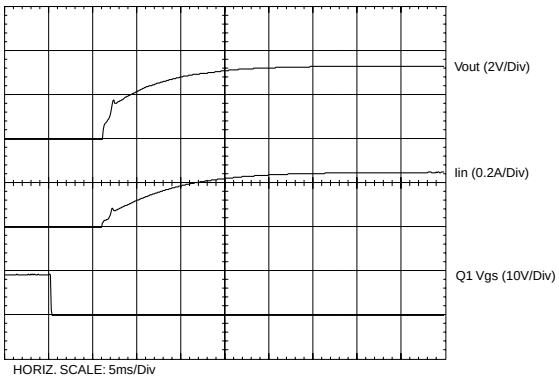
4. The *Remote On/Off* input of the PT4120/40 series regulators must be controlled with an open-collector (or open-drain) discrete transistor or MOSFET. *Do not* use a pull-up resistor.
5. When the converter output is disabled, the current drawn from the input supply is typically reduced to 8mA (16mA 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:-

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

   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

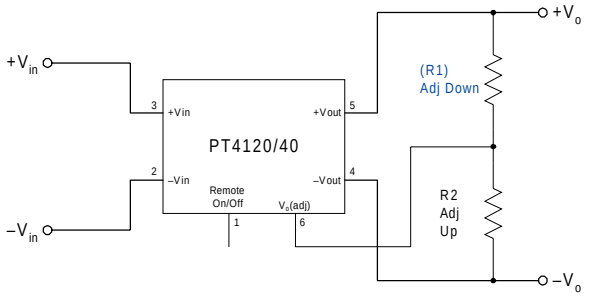


Table 1

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**		**PT4122**		**PT4123**	**PT4124**
24V Bus	**PT4146**	**PT4147**	**PT4148**	**PT4141**		**PT4142**		**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)**		
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_1 = (Blue) R_2 = Black

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
PT4121A	ACTIVE	DIP MOD ULE	EGD	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4121C	ACTIVE	DIP MOD ULE	EGE	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4122A	ACTIVE	DIP MOD ULE	EGD	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4122C	ACTIVE	DIP MOD ULE	EGE	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4122CT	ACTIVE	DIP MOD ULE	EGE	6	100	TBD	Call TI	Level-1-215C-UNLIM
PT4123A	ACTIVE	DIP MOD ULE	EGD	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4123C	ACTIVE	DIP MOD ULE	EGE	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4124A	ACTIVE	DIP MOD ULE	EGD	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4124C	ACTIVE	DIP MOD ULE	EGE	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4125A	ACTIVE	DIP MOD ULE	EGD	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4125C	ACTIVE	DIP MOD ULE	EGE	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4126A	ACTIVE	DIP MOD ULE	EGD	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4126C	ACTIVE	DIP MOD ULE	EGE	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4127A	ACTIVE	DIP MOD ULE	EGD	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4127C	ACTIVE	DIP MOD ULE	EGE	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4128A	ACTIVE	DIP MOD ULE	EGD	6	16	TBD	Call TI	Level-1-215C-UNLIM
PT4128C	ACTIVE	DIP MOD ULE	EGE	6	16	TBD	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.
OBSOLETE: TI has discontinued the production of the device.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) 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.
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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