

## NON-ISOLATED DC/DC CONVERTERS

### 3 – 15V Input / 1.2V Output / 16A



BP02S7DC-16D120

#### S7DC-16D120 Module

- Nonisolated
- Industry standard pinout
- Fixed frequency
- High efficiency means less power dissipation
- High power density
- Optimized for cost
- Remote on/off
- Programmable undervoltage lockout (UVLO)
- Over current and short circuit protection
- Two phase operation
- Non-latching over temperature shutdown protection



#### Description

The Bel S7DC-16D120 module is one in a series of non-isolated, DC/DC power converters that operate from a wide input range of 3V minimum to 15V maximum. This converter is available with 1.2V output. It uses a low profile, surface mount DIP package for ease of layout and space savings. 16A maximum output is also provided. Standard features include remote on/off, over current and short circuit protection, programmable UVLO and output voltage adjust. Optional features include two-wire remote sense or single-ended remote sense with a good power signal. This module also makes use of adaptive positioning to improve transient response performance. It may be used almost anywhere low voltage silicon is employed and a 3 to 15V source is available. Typical applications include file servers, routers, line cards and other computing and communications equipment.

#### Applications

- Telecommunications
- Networking
- Computers and peripherals

#### Options

- Double-ended remote sense
- Power good signal and single-ended sense

#### Part Number Selection

| Output Voltage | Input Voltage | Max. Output Current | Max. Output Power | Typical Efficiency | Part Number | Part Number Power Good Signal & Remote Sense | Part Number Double-ended Remote Sense |
|----------------|---------------|---------------------|-------------------|--------------------|-------------|----------------------------------------------|---------------------------------------|
| 1.2V           | 3 - 15V       | 16A                 | 19W               | 83%                | S7DC-16D120 | S7DC-16D12S                                  | S7DC-16D12D                           |

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### Absolute Maximum Ratings

| Parameter                                   | Symbol             | Min  | Typical | Max | Unit |
|---------------------------------------------|--------------------|------|---------|-----|------|
| Continuous Input Voltage                    | V <sub>in</sub>    | -0.3 |         | 15  | V    |
| Output Enable Terminal Voltage <sup>1</sup> | V <sub>outen</sub> | -0.3 |         | 6   | V    |
| Ambient Temperature                         | T <sub>amb</sub>   | 0    |         | 70  | °C   |
| Storage Temperature                         | T <sub>stor</sub>  | -40  |         | 105 | °C   |

Note: Use beyond the maximum ratings may cause a reliability degradation of the DC/DC converter or may permanently damage the device.

1. The enable pin performs two functions, remote on/off and programmable under voltage lockout. The factory set UVLO point is 3.0V typical, but can be adjusted upward with the addition of a single external resistor located from the enable pin to ground. Turning the converter on and off is accomplished using an open collector/drain device as a switch. The enable pin is internally pulled up to V<sub>in</sub> through a 12.1K resistor and the pin's logic is active high.

### Input Specifications

| Parameter                                         | Symbol          | Min | Typical | Max  | Units             |
|---------------------------------------------------|-----------------|-----|---------|------|-------------------|
| Operating Input Voltage                           | V <sub>in</sub> | 3.1 |         | 15   | V                 |
| Input Current (V <sub>in</sub> =3.3V)             | I <sub>in</sub> |     |         | 7.2  | A                 |
| Input Current (V <sub>in</sub> =5.0V)             | I <sub>in</sub> |     |         | 5    | A                 |
| Input Current (V <sub>in</sub> =12.0V)            | I <sub>in</sub> |     |         | 2.1  | A                 |
| No Load Input Current (V <sub>in</sub> =3.3V)     | I <sub>in</sub> |     |         | 200  | mA                |
| No Load Input Current (V <sub>in</sub> =5.0V)     | I <sub>in</sub> |     |         | 150  | mA                |
| No Load Input Current (V <sub>in</sub> =12.0V)    | I <sub>in</sub> |     |         | 100  | mA                |
| Input Reflected Ripple Current <sup>1</sup>       |                 |     |         | 50   | mA <sub>rms</sub> |
| Input Reflected Ripple Current (P-P) <sup>1</sup> |                 |     |         | 100  | mApk              |
| I <sup>2</sup> t Inrush Current Transient         |                 |     |         | 0.1  | A <sup>2</sup> s  |
| Turn On Voltage Threshold <sup>2</sup>            |                 |     | 2.92    |      | V                 |
| Turn Off Voltage Threshold                        |                 | 2.8 | 2.85    | 2.90 | V                 |

Note: Input capacitance 100μF/16V, ESR = 0.03 Ω max at 100kHz @ 25° C.

1. With simulated source impedance of 500nH, 5Hz to 20MHz.
2. UVLO is adjustable by terminating on/off pin to ground per the termination resistance table on page 7.

# NON-ISOLATED DC/DC CONVERTERS

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### Output Specifications

| Parameter                                     | Symbol  | Min  | Typical | Max  | Units |
|-----------------------------------------------|---------|------|---------|------|-------|
| Output Voltage Set Point                      | Vout    | 1.20 | 1.22    | 1.25 | V     |
| Load Regulation (Droop Impedance)             | Rout    | 2    | 2.5     | 3    | mΩ    |
| Line Regulation<br>Input Voltage 3.1V to 15V  |         |      | 15      | 25   | mV    |
| Line Regulation<br>Input Voltage 5V ±20%      |         |      | 3       | 10   | mV    |
| Regulation Over Temperature<br>0° - 70° C     |         |      | 10      | 25   | mV    |
| Output Ripple and Noise <sup>1</sup>          |         |      | 25      | 40   | mVp-p |
| Output Ripple and Noise <sup>1</sup>          |         |      | 10      | 20   | mVrms |
| Output Current Range                          | Iout    | 0    |         | 16   | A     |
| Output DC Current Limit                       | Ioutlim | 18   |         | 22   | A     |
| Turn on Time<br>Vin to Vout or on/off to Vout | Ton     |      | 8       | 10   | ms    |
| Overshoot at Turn On                          |         |      | 0       | 1    | %     |
| Output Capacitance                            | Cout    | 100  |         | 2200 | μF    |

Note: All specifications are typical at nominal input, full load at 25° C unless otherwise stated.

1. 0 - 20MHz BW, 0.1μF ceramic cap on output.

### Output Specifications

| Parameter                                          | Symbol | Min | Typical | Max | Units   |
|----------------------------------------------------|--------|-----|---------|-----|---------|
| <b>Transient Response <sup>2</sup> (Vin=3.3V)</b>  |        |     |         |     |         |
| $\Delta V$ 50% to 100% of Max Load                 |        |     | 60      | 75  | mV      |
| Settling Time                                      | Ts     |     | 100     | 120 | $\mu s$ |
| $\Delta V$ 100% to 50% of Max Load                 |        |     | 60      | 75  | mV      |
| Settling Time                                      | Ts     |     | 100     | 120 | $\mu s$ |
| <b>Transient Response <sup>2</sup> (Vin=5.0V)</b>  |        |     |         |     |         |
| $\Delta V$ 50% to 100% of Max Load                 |        |     | 100     | 120 | mV      |
| Settling Time                                      | Ts     |     | 100     | 120 | $\mu s$ |
| $\Delta V$ 100% to 50% of Max Load                 |        |     | 100     | 120 | mV      |
| Settling Time                                      | Ts     |     | 100     | 120 | $\mu s$ |
| <b>Transient Response <sup>2</sup> (Vin=12.0V)</b> |        |     |         |     |         |
| $\Delta V$ 50% to 100% of Max Load                 |        |     | 135     | 150 | mV      |
| Settling Time                                      | Ts     |     | 100     | 120 | $\mu s$ |
| $\Delta V$ 100% to 50% of Max Load                 |        |     | 135     | 150 | mV      |
| Settling Time                                      | Ts     |     | 100     | 120 | $\mu s$ |

Note: All specifications are typical at nominal input, full load at 25° C unless otherwise stated.

2. di/dt = 1A/1 $\mu$ S, Ta = 25° C with a 560 $\mu$ F oscon cap on output.

# NON-ISOLATED DC/DC CONVERTERS

## 3 – 15V Input / 1.2V Output / 16A



### General Specifications

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| Parameter                                            | Symbol | Min | Typical | Max | Units |
|------------------------------------------------------|--------|-----|---------|-----|-------|
| Efficiency <sup>1</sup> (Vin=3.3V)                   | $\eta$ | 81  | 83      |     | %     |
| Efficiency <sup>2</sup> (Vin=5.0V)                   | $\eta$ | 80  | 82      |     | %     |
| Efficiency <sup>3</sup> (Vin=12.0V)                  | $\eta$ | 77  | 80      |     | %     |
| Switching Frequency                                  | Fsw    | 495 | 550     | 605 | kHz   |
| Output Voltage Trim Range <sup>4</sup>               |        | 90  |         | 110 | %     |
| Remote Sense Compensation<br>(when option specified) |        |     |         | 300 | mV    |
| Weight                                               |        |     | 16      |     | g     |

1. Vin=3.3V, full load and Ta=25° C.
2. Vin=5.0V, full load and Ta=25° C.
3. Vin=12.0V, full load and Ta=25° C.
4. See graph on page 7.

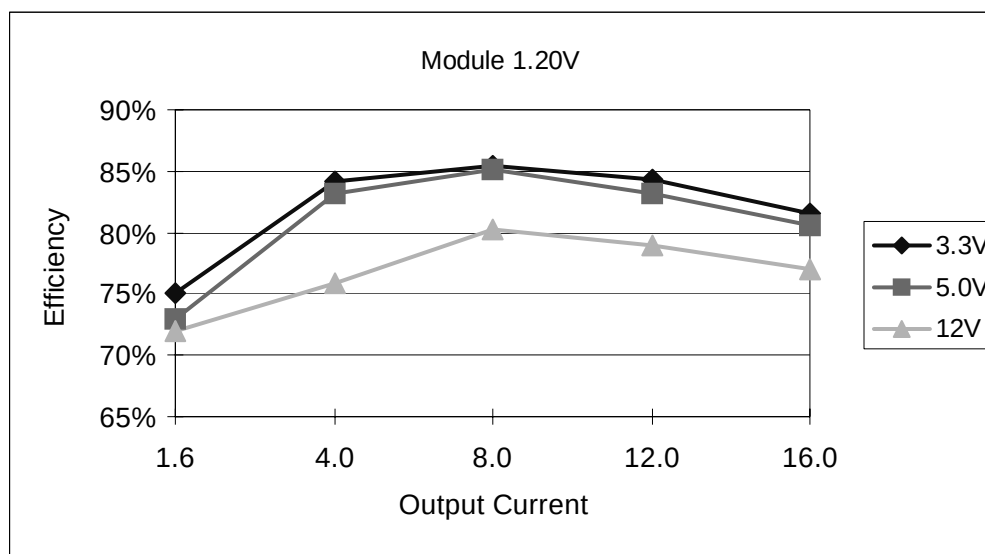
### Control Specifications

| Parameter                                                        | Symbol | Min  | Typical | Max  | Units      |
|------------------------------------------------------------------|--------|------|---------|------|------------|
| Remote On/Off<br>Open Circuit Voltage (Vin=3.3V)                 | Vouten |      |         | 1.4  | V          |
| Remote On/Off<br>Open Circuit Voltage (Vin=5.0V)                 | Vouten |      |         | 2.1  | V          |
| Remote On/Off<br>Open Circuit Voltage (Vin=12.0V)                | Vouten |      |         | 5.1  | V          |
| Remote On/Off<br>Impedance Limitation<br>(pin pulled up to +Vin) | Renale |      |         | 11.5 | k $\Omega$ |
| Signal Low (Unit Off)                                            |        | -0.3 |         | 0.3  | V          |
| Signal High (Unit On)                                            |        | 1.5  |         | 5.5  | V          |
| Power Good Levels<br>(when option specified)                     | Vpg    |      |         |      |            |
| Signal Low                                                       |        |      | 0.18    | 0.4  | V          |
| Current Sink                                                     |        |      |         | 4    | mA         |
| Signal High<br>(signal is open collector)                        |        |      |         | 5    | V          |
| Under Voltage Threshold<br>Vout rising                           |        |      | 1.1     |      | V          |
| Under Voltage Threshold<br>Vout falling                          |        |      | 1.08    |      | V          |

Note: On/off pin designed to work with an open collector/drain switch.

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## Efficiency Data



# NON-ISOLATED DC/DC CONVERTERS

## 3 – 15V Input / 1.2V Output / 16A

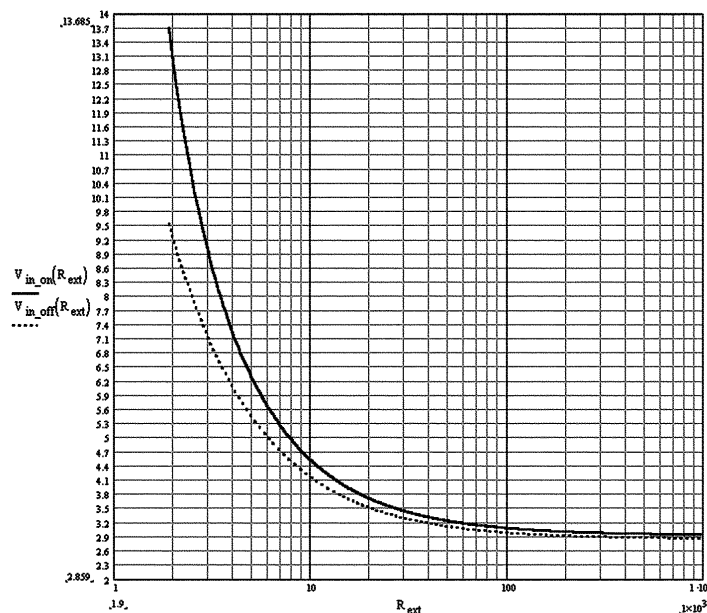


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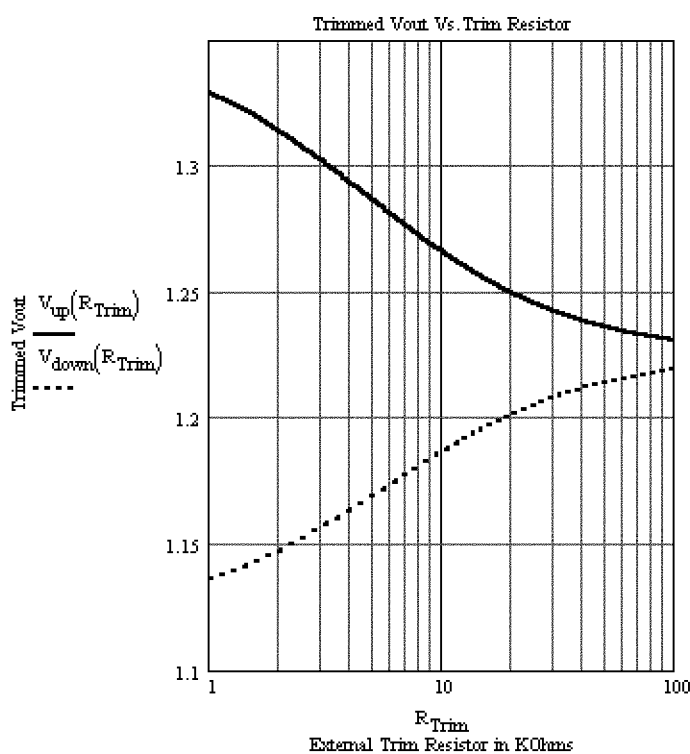
### Termination Resistance

| Termination Resistance | Rising Vin UVLO | Falling Vin UVLO |
|------------------------|-----------------|------------------|
| Open Circuit           | 2.92V           | 2.85V            |
| 10.2K $\Omega$         | 4.50V           | 4.14V            |
| 5.36K $\Omega$         | 6.06V           | 5.28V            |
| 4.75K $\Omega$         | 6.50V           | 5.60V            |
| 3.48K $\Omega$         | 8.00V           | 6.58V            |
| 3.01K $\Omega$         | 9.00V           | 7.14V            |
| 2.49K $\Omega$         | 10.5V           | 8.00V            |
| 2.37K $\Omega$         | 11.0V           | 8.26V            |

### UVLO



### Output Voltage Trim Range



$$V_{up}(10^9) = 1.225$$

$$V_{down}(10^9) = 1.225$$

Trimmed Vout for Various K-Ohm E96 Resistor Values

$$V_{up}(30.1) = 1.243$$

$$V_{down}(30.1) = 1.208$$

$$V_{up}(12.1) = 1.261$$

$$V_{down}(12.1) = 1.191$$

$$V_{up}(10) = 1.266$$

$$V_{down}(10) = 1.186$$

$$V_{up}(5.11) = 1.286$$

$$V_{down}(5.11) = 1.169$$

$$V_{up}(4.32) = 1.292$$

$$V_{down}(4.32) = 1.165$$

$$V_{up}(3.83) = 1.295$$

$$V_{down}(3.83) = 1.162$$

$$V_{up}(3.01) = 1.303$$

$$V_{down}(3.01) = 1.156$$

$$V_{up}(2.87) = 1.304$$

$$V_{down}(2.87) = 1.155$$

$$V_{up}(2.67) = 1.306$$

$$V_{down}(2.67) = 1.153$$

$$V_{up}(2.00) = 1.314$$

$$V_{down}(2.00) = 1.147$$

$$V_{up}(1.00) = 1.329$$

$$V_{down}(1.00) = 1.136$$

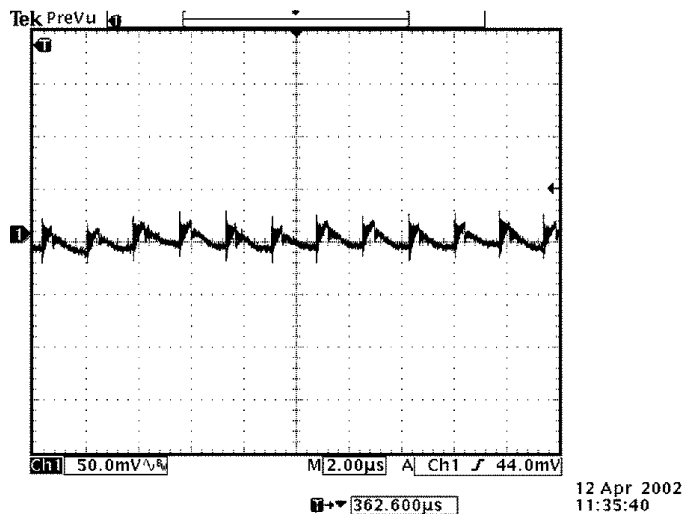
$$V_{up}(0) = 1.351$$

$$V_{down}(0) = 1.121$$

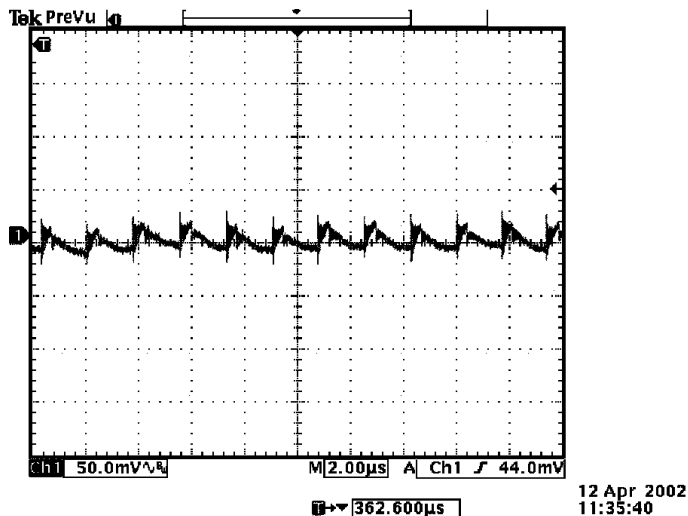
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## Ripple and Noise



Ripple and noise at full load and 12.0Vdc input,  
and  $T_a=25^{\circ}\text{C}$



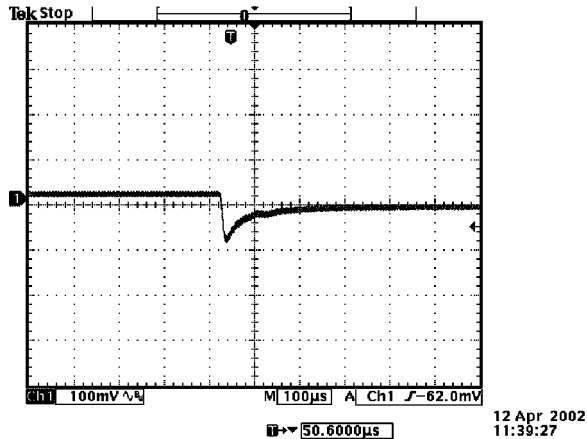
Ripple and noise at full load and 12.0Vdc input,  
and  $T_a=25^{\circ}\text{C}$  with 560  $\mu\text{F}$  external cap



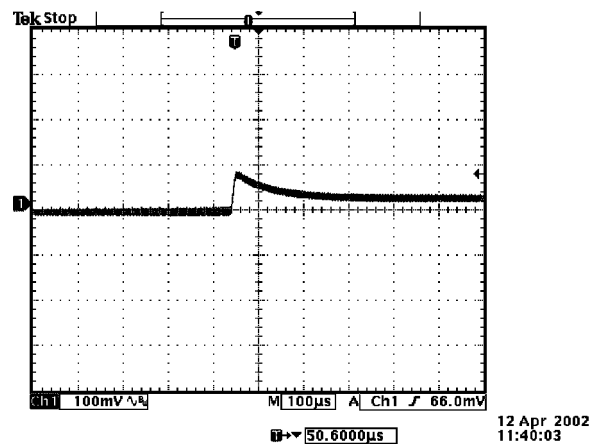
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## Transient Response

Transient response:  $di/dt = 1.0A/\mu S$

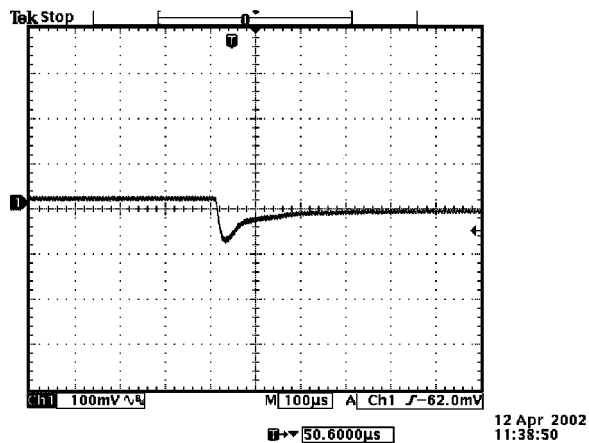


Vout=1.2V  
50% to 100% load transients at 12.0V input and Ta=25° C

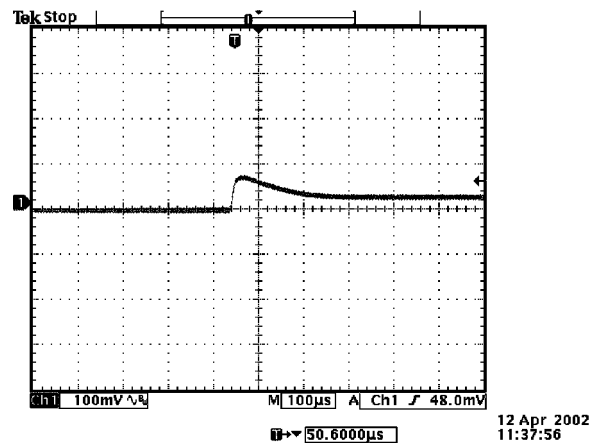


Vout=1.2V  
100% to 50% load transients at 12.0V input and Ta=25° C

Transient response:  $di/dt = 1.0A/\mu S$ , external load capacitance 560μF

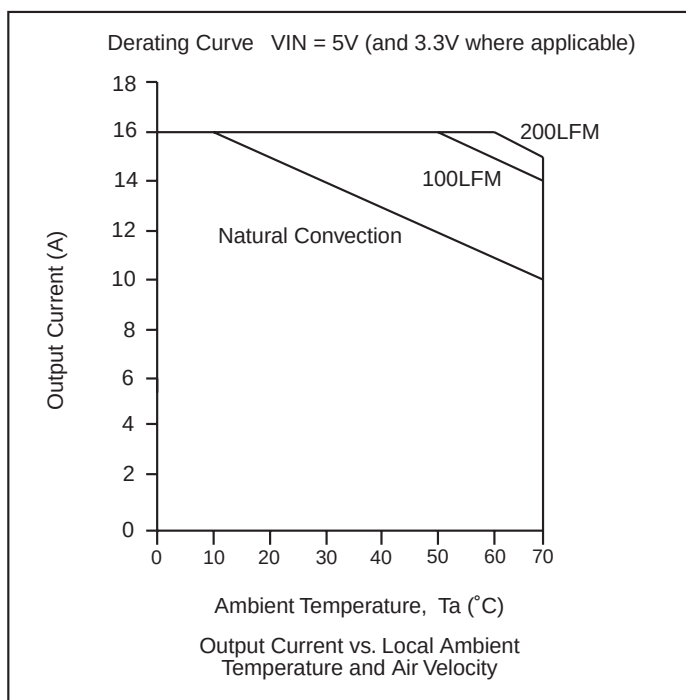
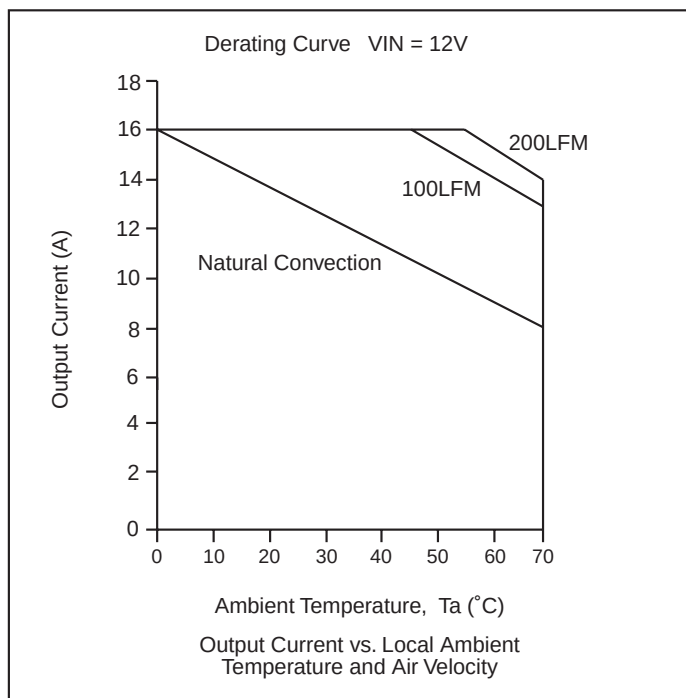


Vout=1.2V  
50% to 100% load transients at 12.0V input and Ta=25° C



Vout=1.2V  
100% to 50% load transients at 12.0V input and Ta=25° C

## Thermal Considerations



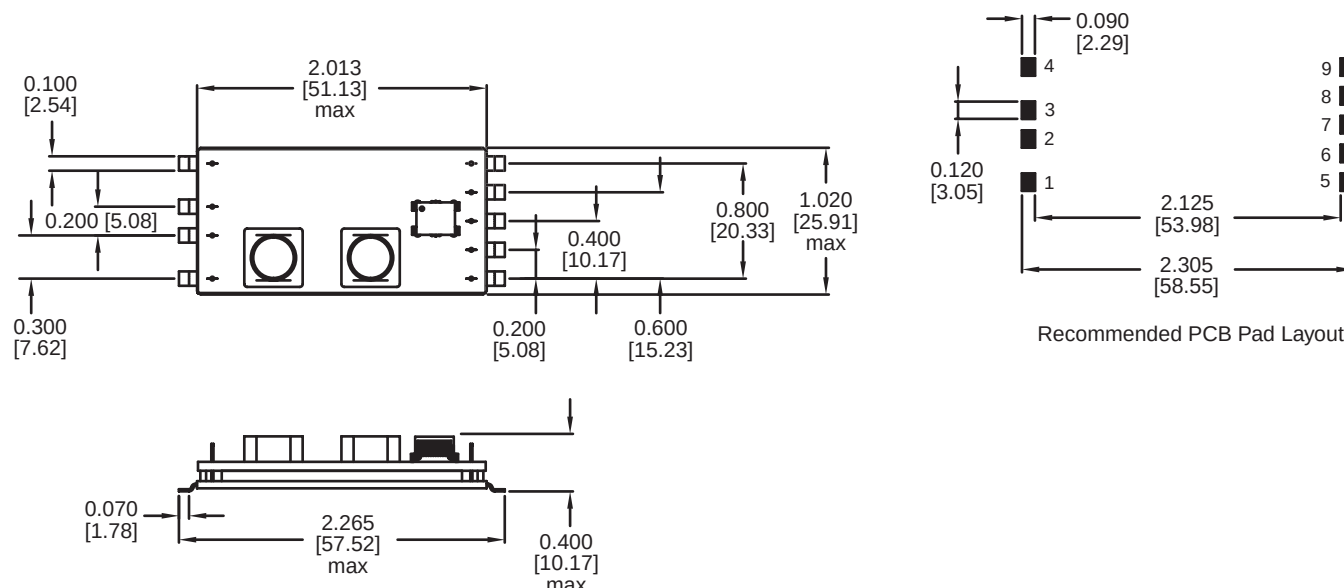
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3 – 15V Input / 1.2V Output / 16A



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## Mechanical



Dimensions are in inches [millimeters].

Standard dimension tolerance is  $\pm 0.005$  [0.13] unless otherwise noted.

| Pin            | Function       |
|----------------|----------------|
| 1              | Control Ground |
| 2              | On/Off Control |
| 3 <sup>1</sup> | No Connection  |
| 4 <sup>2</sup> | No Connection  |
| 5              | +Vo            |
| 6              | Trim           |
| 7              | Power Ground   |
| 8              | Power Ground   |
| 9              | +Vin           |

1. Pin 3 not used on module S7DC-16D120, used for - sense on S7DC-16D12D and used for power good signal on the S7DC-16D12S module.

2. Pin 4 not used on module S7DC-16D120, used for + sense on both the S7DC-16D12S and S7DC-16D12D modules.

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