

# DELPHI SERIES



## FEATURES

- ♦ High Efficiency: 93%@ 5Vin, 3.3V/5A out
- ♦ Small size and low profile:  
0.80" x 0.45" x 0.27" (SMD)  
0.90" x 0.40" x 0.25" (SIP)
- ♦ Standard footprint and pinout
- ♦ Resistor-based trim
- ♦ Output voltage programmable from 0.75V to 3.63V via external resistors
- ♦ Pre-bias startup
- ♦ No minimum load required
- ♦ Fixed frequency operation
- ♦ Input UVLO, OCP
- ♦ Remote ON/OFF
- ♦ ISO 9001, TL 9000, ISO 14001, QS 9000, OHSAS 18001 certified manufacturing facility
- ♦ UL/cUL 60950 (US & Canada) Recognized

## Delphi DNT04, Non-Isolated Point of Load DC/DC Power Modules: 2.4~5.5Vin, 0.75~3.63Vo, 5A out

The Delphi Series DNT04, 2.4-5.5V input, single output, non-isolated Point of Load DC/DC converters are the latest offering from a world leader in power systems technology and manufacturing — Delta Electronics, Inc. The DNT04 series provides a programmable output voltage from 0.75V to 3.63V via external resistors. This product family is available in surface mount or SIP package and provides up to 5A of output current in an industry standard footprint. With creative design technology and optimization of component placement, these converters possess outstanding electrical and thermal performance, as well as extremely high reliability under highly stressful operating conditions. The DNT04, 5A modules have excellent thermal performance and can provide full output current at up to 85°C ambient temperature with no airflow.

## OPTIONS

- ♦ Positive On/Off logic
- ♦ SMD or SIP package

## APPLICATIONS

- ♦ Telecom/DataCom
- ♦ Distributed power architectures
- ♦ Servers and workstations
- ♦ LAN/WAN applications
- ♦ Data processing applications

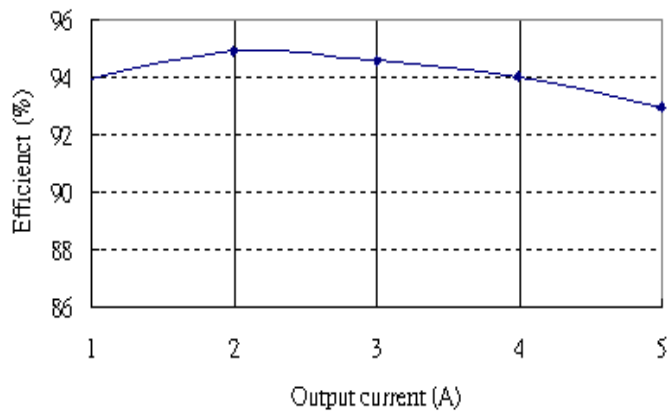
## TECHNICAL SPECIFICATIONS

(T<sub>A</sub> = 25°C, airflow rate = 300 LFM, V<sub>in</sub> = 2.4Vdc and 5.5Vdc, nominal V<sub>out</sub> unless otherwise noted.)

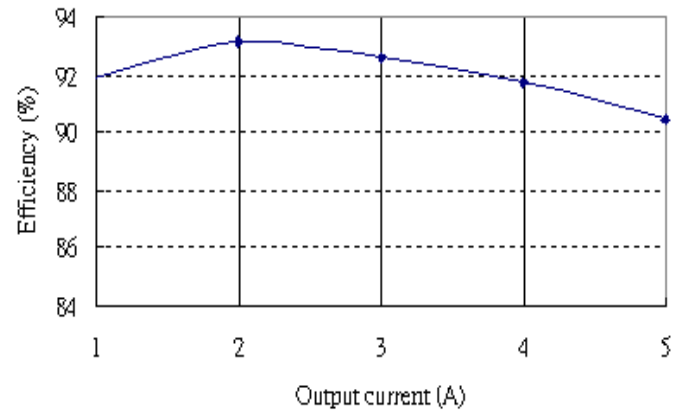
| PARAMETER                                  | NOTES and CONDITIONS                          | DNT04S0A0R05NFA |        |         |           |
|--------------------------------------------|-----------------------------------------------|-----------------|--------|---------|-----------|
|                                            |                                               | Min.            | Typ.   | Max.    | Units     |
| ABSOLUTE MAXIMUM RATINGS                   |                                               |                 |        |         |           |
| Input Voltage (Continuous)                 |                                               | 0               |        | 5.8     | Vdc       |
| Operating Temperature                      |                                               | -40             |        | 85      | °C        |
| Storage Temperature                        |                                               | -55             |        | 125     | °C        |
| INPUT CHARACTERISTICS                      |                                               |                 |        |         |           |
| Operating Input Voltage                    | Vo ≤ Vin –0.5V                                | 2.4             |        | 5.5     | V         |
| Input Under-Voltage Lockout                |                                               |                 |        |         |           |
| Turn-On Voltage Threshold                  |                                               |                 | 2.1    |         | V         |
| Turn-Off Voltage Threshold                 |                                               |                 | 2.0    |         | V         |
| Maximum Input Current                      | Vin=4.5V Vo=3.3V, Io=Io,max                   |                 |        | 4.1     | A         |
| No-Load Input Current                      |                                               |                 | 30     | 45      | mA        |
| Off Converter Input Current                |                                               |                 | 1      |         | mA        |
| Inrush Transient                           | Vin=2.4V to 5.5V, Io=Io,min to Io,max         |                 |        | 0.1     | A°S       |
| Recommended Input Fuse                     |                                               | 7               |        |         | A         |
| OUTPUT CHARACTERISTICS                     |                                               |                 |        |         |           |
| Output Voltage Set Point                   | Vin=5V, Io=Io, max                            | -2.0            | Vo,set | +2.0    | % Vo,set  |
| Output Voltage Adjustable Range            |                                               | 0.7525          |        | 3.63    | V         |
| Output Voltage Regulation                  |                                               |                 |        |         |           |
| Over Line                                  | Vin=2.4V to 5.5V                              |                 | 0.3    |         | % Vo,set  |
| Over Load                                  | Io=Io,min to Io,max                           |                 | 0.4    |         | % Vo,set  |
| Over Temperature                           | Ta=-40°C to 85°C                              |                 | 0.4    |         | % Vo,set  |
| Total Output Voltage Range                 | Over sample load, line and temperature        | -3.0            |        | +3.0    | % Vo,set  |
| Output Voltage Ripple and Noise            | 5Hz to 20MHz bandwidth                        |                 |        |         |           |
| Peak-to-Peak                               | Full Load, 1µF ceramic, 10µF tantalum         |                 | 40     | 60      | mV        |
| RMS                                        | Full Load, 1µF ceramic, 10µF tantalum         |                 | 10     | 15      | mV        |
| Output Current Range                       |                                               | 0               |        | 5       | A         |
| Output Voltage Over-shoot at Start-up      |                                               |                 |        | 5       | % Vo,set  |
| Output DC Current-Limit Inception          |                                               |                 | 220    |         | % Io      |
| Output Short-Circuit Current (Hiccup Mode) | Io,s/c                                        |                 | 3      |         | Adc (rms) |
| DYNAMIC CHARACTERISTICS                    |                                               |                 |        |         |           |
| Dynamic Load Response                      | 10µF Tantalum & 1µF Ceramic load cap, 2.5A/µs |                 |        |         |           |
| Positive Step Change in Output Current     | 50% Io, max to 100% Io, max                   |                 | 220    |         | mV        |
| Negative Step Change in Output Current     | 100% Io, max to 50% Io, max                   |                 | 220    |         | mV        |
| Setting Time to 10% of Peak Deviation      |                                               |                 | 25     |         | µs        |
| Turn-On Transient                          | Io=Io,max                                     |                 |        |         |           |
| Start-Up Time, From On/Off Control         | Von/off, Vo=10% of Vo,set                     |                 | 7      |         | ms        |
| Start-Up Time, From Input                  | Vin=Vin,min, Vo=10% of Vo,set                 |                 | 7      |         | ms        |
| Maximum Output Startup Capacitive Load     | Full load; ESR ≥ 1mΩ                          |                 |        | 1000    | µF        |
|                                            | Full load; ESR ≥ 10mΩ                         |                 |        | 3000    | µF        |
| EFFICIENCY                                 |                                               |                 |        |         |           |
| Vo=3.3V                                    | Vin=5V, 100% Load                             |                 | 93.0   |         | %         |
| Vo=2.5V                                    | Vin=5V, 100% Load                             |                 | 90.5   |         | %         |
| Vo=1.8V                                    | Vin=5V, 100% Load                             |                 | 87.5   |         | %         |
| Vo=1.5V                                    | Vin=5V, 100% Load                             |                 | 86.0   |         | %         |
| Vo=1.2V                                    | Vin=5V, 100% Load                             |                 | 83.5   |         | %         |
| Vo=0.75V                                   | Vin=5V, 100% Load                             |                 | 77.5   |         | %         |
| FEATURE CHARACTERISTICS                    |                                               |                 |        |         |           |
| Switching Frequency                        |                                               |                 | 300    |         | kHz       |
| ON/OFF Control, (Negative logic)           |                                               |                 |        |         |           |
| Logic Low Voltage                          | Module On, Von/off                            | -0.2            |        | 0.3     | V         |
| Logic High Voltage                         | Module Off, Von/off                           | 2.5             |        | Vin,max | V         |
| Logic Low Current                          | Module On, Ion/off                            |                 |        | 10      | µA        |
| Logic High Current                         | Module Off, Ion/off                           |                 | 0.2    | 1       | mA        |
| GENERAL SPECIFICATIONS                     |                                               |                 |        |         |           |
| MTBF                                       | Io=100% of Io, max; Ta=25°C                   |                 | 19.3   |         | M hours   |
| Weight                                     |                                               |                 | 2.3    |         | grams     |



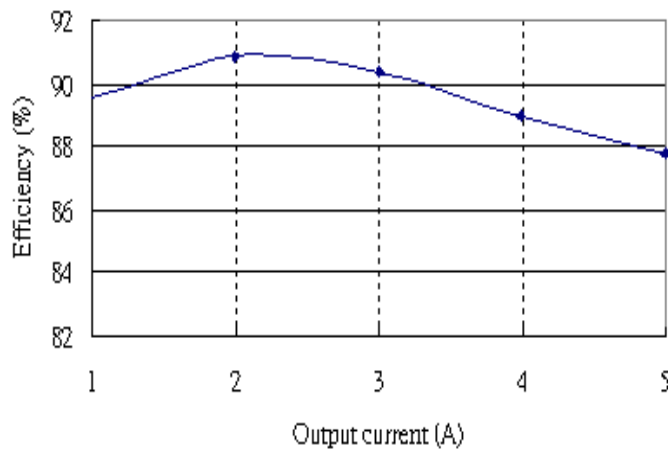
## ELECTRICAL CHARACTERISTICS CURVES



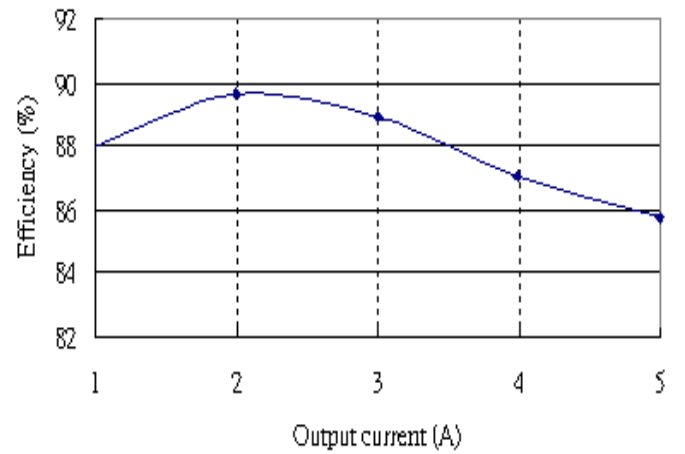
**Figure 1:** Converter efficiency vs. output current (5Vin/3.3Vout)



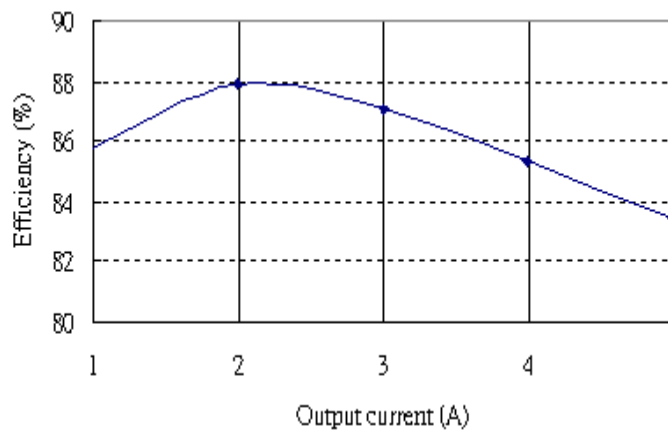
**Figure 2:** Converter efficiency vs. output current (5Vin/2.5Vout)



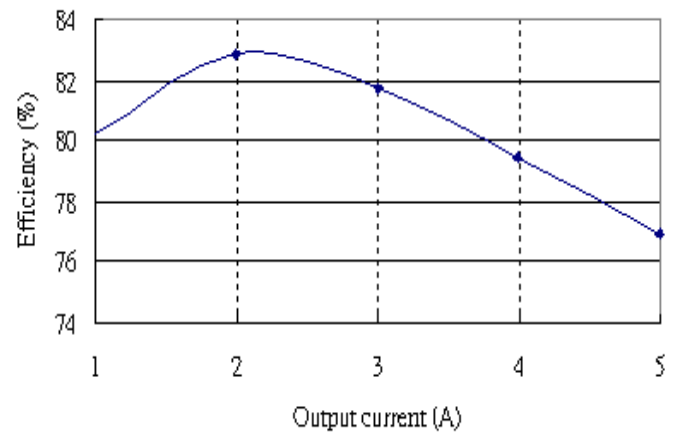
**Figure 3:** Converter efficiency vs. output current (5Vin/1.8Vout)



**Figure 4:** Converter efficiency vs. output current (5Vin/1.5Vout)



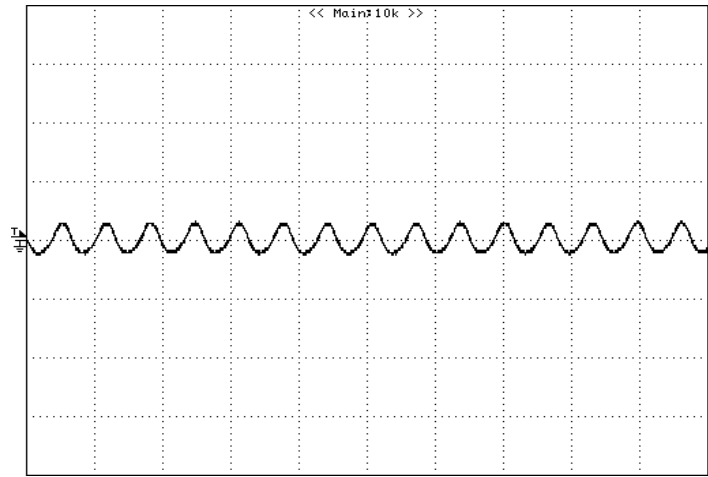
**Figure 5:** Converter efficiency vs. output current (5Vin/1.2Vout)



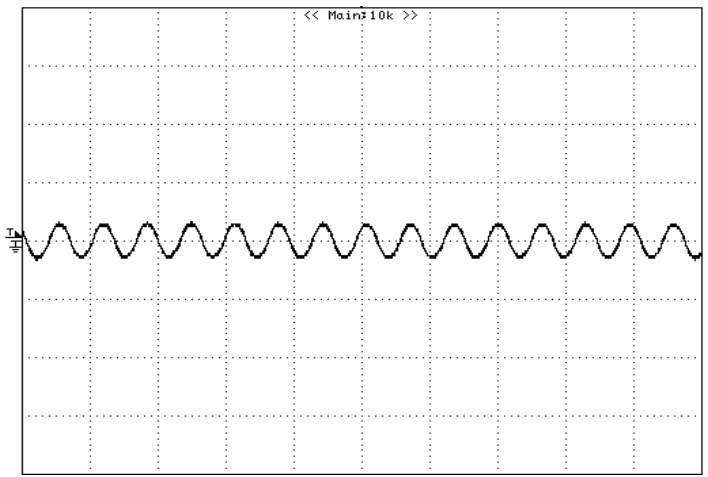
**Figure 6:** Converter efficiency vs. output current (5Vin/0.75Vout)



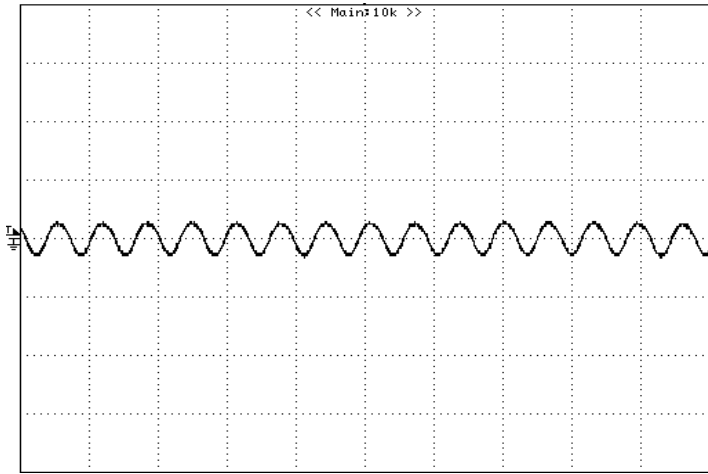
## ELECTRICAL CHARACTERISTICS CURVES (CON.)



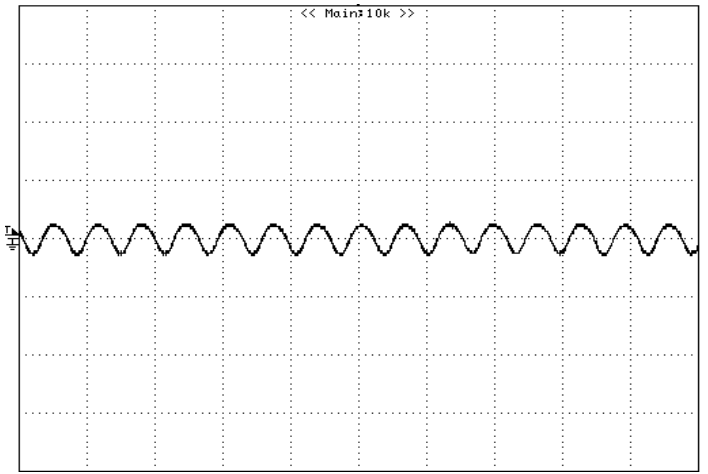
**Figure 7:** Output ripple & noise at 5Vin, 3.3V/5A out, 50mV/div



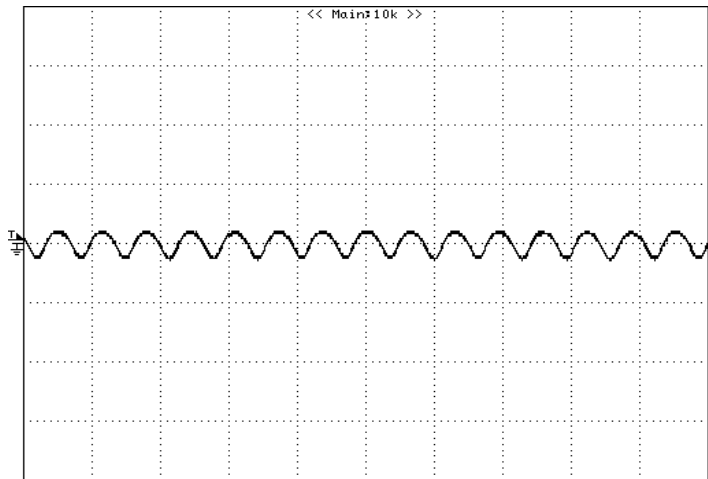
**Figure 8:** Output ripple & noise at 5Vin, 2.5V/5A out, 50mV/div



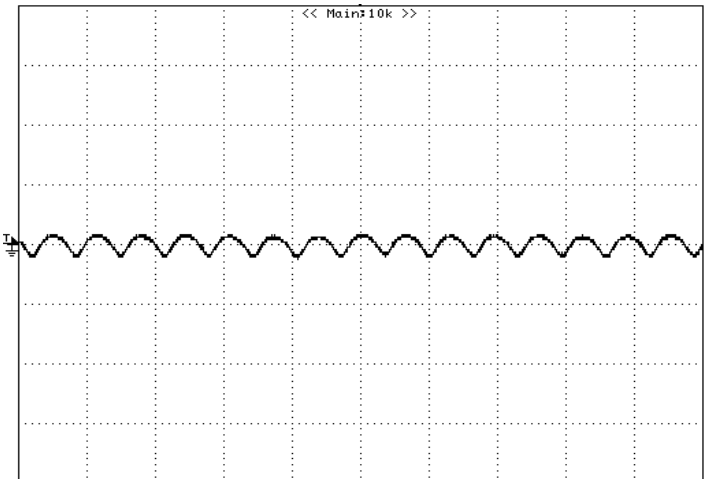
**Figure 9:** Output ripple & noise at 5Vin, 1.8V/5A out, 50mV/div



**Figure 10:** Output ripple & noise at 5Vin, 1.5V/5A out, 50mV/div



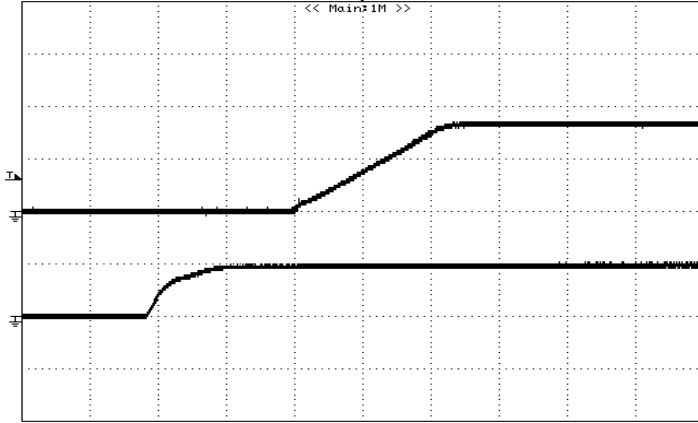
**Figure 11:** Output ripple & noise at 5Vin, 1.2V/5A out, 50mV/div



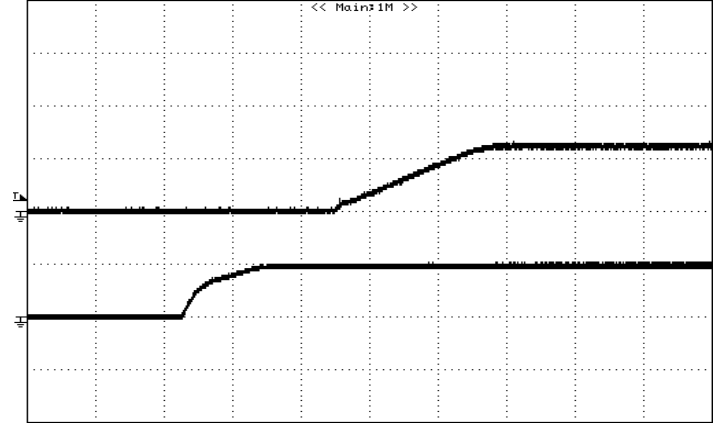
**Figure 12:** Output ripple & noise at 5Vin, 0.75V/5A out, 50mV/div



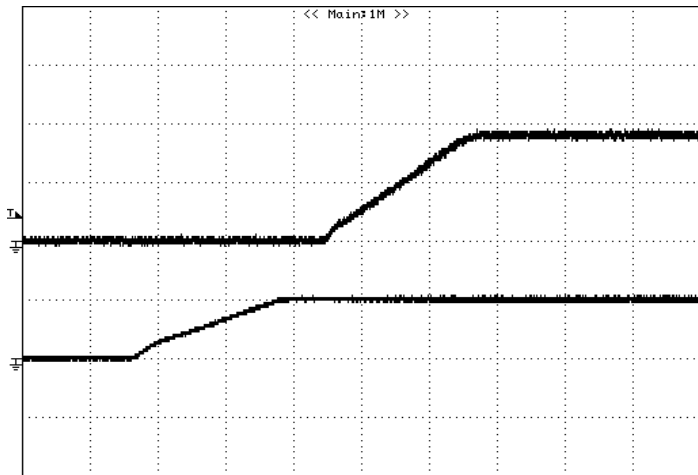
## ELECTRICAL CHARACTERISTICS CURVES (CON.)



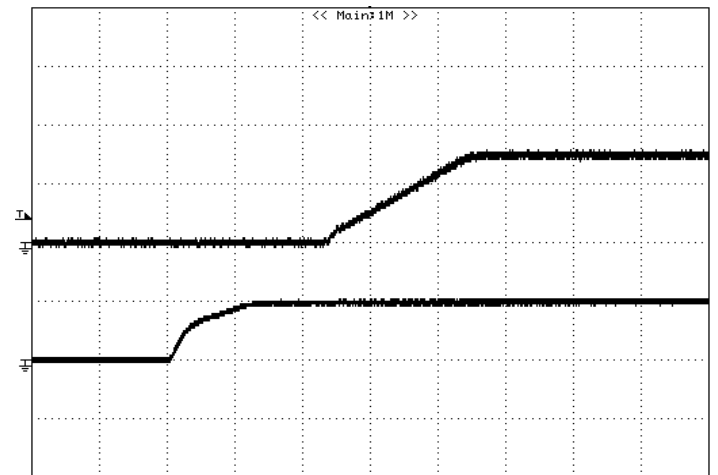
**Figure 13:** Turn on delay time at 5Vin, 3.3V/5A out  
Top: Vout, 2V/div, Bottom: Vin, 5V/div; 2mS/div



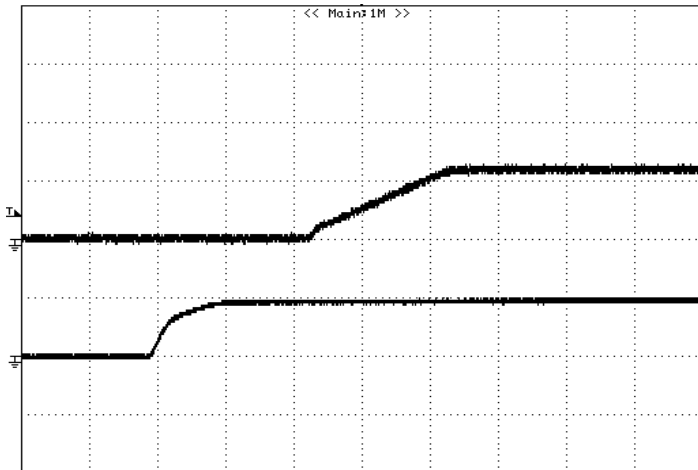
**Figure 14:** Turn on delay time at 5Vin, 2.5V/5A out  
Top: Vout, 2V/div, Bottom: Vin, 5V/div; 2mS/div



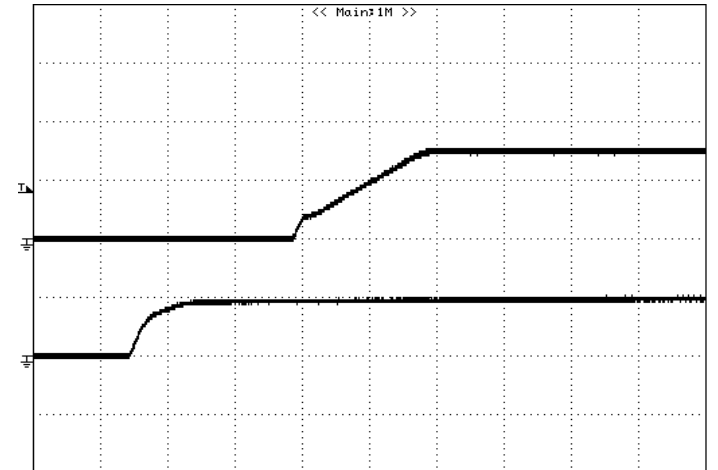
**Figure 15:** Turn on delay time at 5Vin, 1.8V/5A out  
Top: Vout, 1V/div, Bottom: Vin, 5V/div; 2mS/div



**Figure 16:** Turn on delay time at 5Vin, 1.5V/5A out  
Top: Vout, 1V/div, Bottom: Vin, 5V/div; 2mS/div

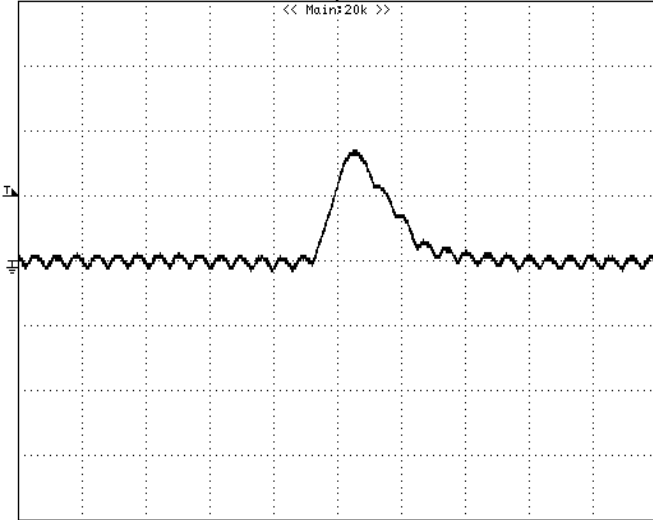


**Figure 17:** Turn on delay time at 5Vin, 1.2V/5A out  
Top: Vout, 1V/div, Bottom: Vin, 5V/div; 2mS/div

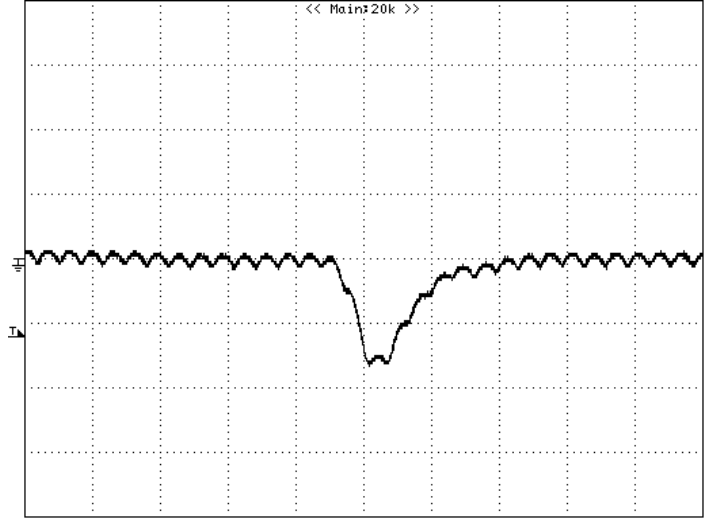


**Figure 18:** Turn on delay time at 5Vin, 0.75V/5A out  
Top: Vout, 0.5V/div, Bottom: Vin, 5V/div; 2mS/div

## ELECTRICAL CHARACTERISTICS CURVES



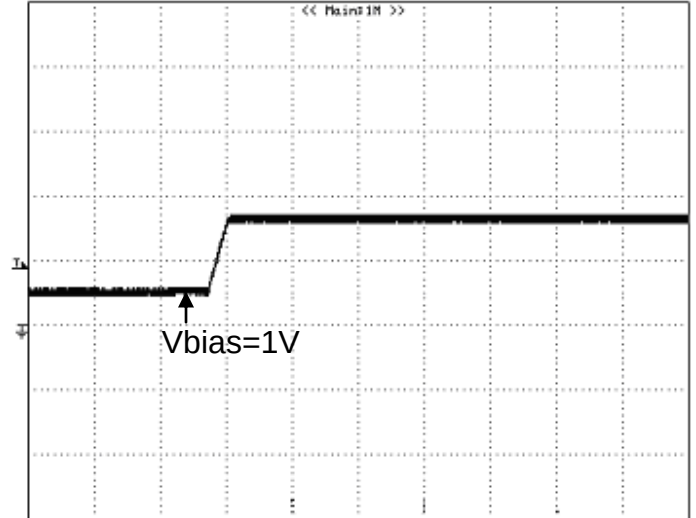
**Figure 19:** Typical transient response to step load change at  $2.5\text{A}/\mu\text{S}$  from 100% to 50% of  $I_o$ , max at  $5\text{V}_{in}$ ,  $3.3\text{V}_{out}$  ( $C_{out} = 1\mu\text{F}$  ceramic,  $10\mu\text{F}$  tantalum),  $0.1\text{V}/\text{div}$



**Figure 20:** Typical transient response to step load change at  $2.5\text{A}/\mu\text{S}$  from 50% to 100% of  $I_o$ , max at  $5\text{V}_{in}$ ,  $3.3\text{V}_{out}$  ( $C_{out} = 1\mu\text{F}$  ceramic,  $10\mu\text{F}$  tantalum),  $0.1\text{V}/\text{div}$



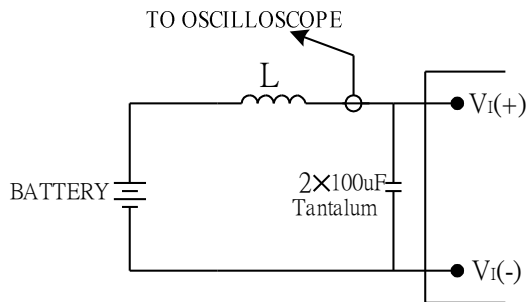
**Figure 21:** Output short circuit current  $5\text{V}_{in}$ ,  $0.75\text{V}_{out}$   $20\text{A}/\text{div}$ ,  $10\text{mS}/\text{div}$



**Figure 22:** Turn on with Prebias  $5\text{V}_{in}$ ,  $3.3\text{V}/0\text{A}$  out,  $V_{bias} = 1.0\text{V}_{dc}$   $2\text{V}/\text{div}$ ,  $10\text{mS}/\text{div}$

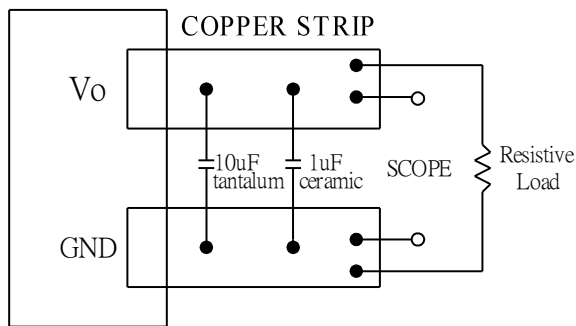


## TEST CONFIGURATIONS



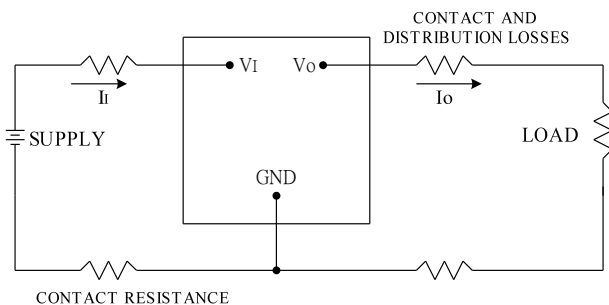
**Note:** Input reflected-ripple current is measured with a simulated source inductance. Current is measured at the input of the module.

**Figure 23:** Input reflected-ripple test setup



**Note:** Use a 10µF tantalum and 1µF capacitor. Scope measurement should be made using a BNC connector.

**Figure 24:** Peak-peak output noise and startup transient measurement test setup.



**Figure 25:** Output voltage and efficiency measurement test setup

**Note:** All measurements are taken at the module terminals. When the module is not soldered (via socket), place Kelvin connections at module terminals to avoid measurement errors due to contact resistance.

$$\eta = \left( \frac{V_o \times I_o}{V_i \times I_i} \right) \times 100 \quad \%$$

## DESIGN CONSIDERATIONS

### Input Source Impedance

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the module. An input capacitance must be placed close to the modules input pins to filter ripple current and ensure module stability in the presence of inductive traces that supply the input voltage to the module.

### Safety Considerations

For safety-agency approval the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standards.

For the converter output to be considered meeting the requirements of safety extra-low voltage (SELV), the input must meet SELV requirements. The power module has extra-low voltage (ELV) outputs when all inputs are ELV.

The input to these units is to be provided with a adequate time-delay fuse in the ungrounded lead.





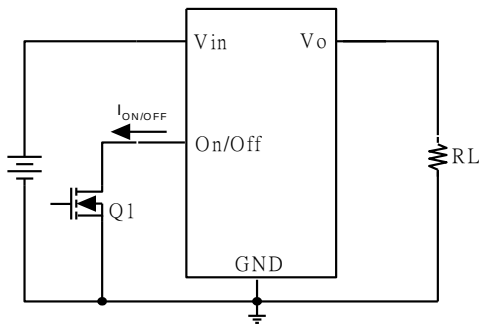
## FEATURES DESCRIPTIONS

### Remote On/Off

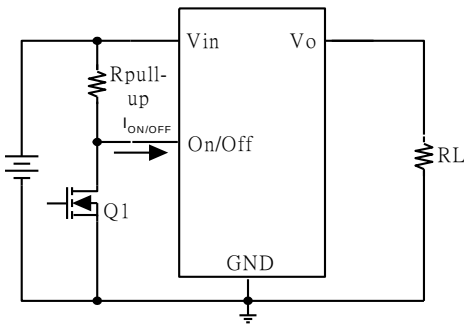
The DNT series power modules have an On/Off pin for remote On/Off operation. Both positive and negative On/Off logic options are available in the DNT series power modules.

For positive logic module, connect an open collector (NPN) transistor or open drain (N channel) MOSFET between the On/Off pin and the GND pin (see figure 26). Positive logic On/Off signal turns the module ON during the logic high and turns the module OFF during the logic low. When the positive On/Off function is not used, leave the pin floating or tie to Vin (module will be On).

For negative logic module, the On/Off pin is pulled high with an external pull-up resistor (see figure 27). Negative logic On/Off signal turns the module OFF during logic high and turns the module ON during logic low. If the negative On/Off function is not used, tie the pin to GND. (module will be On)



**Figure 26:** Positive remote On/Off implementation



**Figure 27:** Negative remote On/Off implementation

### Over-Current Protection

To provide protection in an output over load fault condition, the unit is equipped with internal over-current protection. When the over-current protection is triggered, the unit enters hiccup mode. The units operate normally once the fault condition is removed.

DS\_DNT04SIP05\_08292013

## FEATURES DESCRIPTIONS (CON.)

### Output Voltage Programming

The output voltage of the DNT can be programmed to any voltage between 0.75Vdc and 3.63Vdc by connecting one resistor (shown as Rtrim in Figure 28) between the TRIM and GND pins of the module. Without this external resistor, the output voltage of the module is 0.7525 Vdc. To calculate the value of the resistor Rtrim for a particular output voltage Vo, please use the following equation:

$$R_{trim} = \left[ \frac{21070}{V_o - 0.7525} - 5110 \right] \Omega$$

For example, to program the output voltage of the DNS module to 1.8Vdc, Rtrim is calculated as follows:

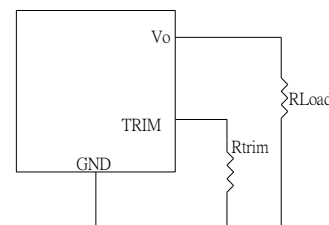
$$R_{trim} = \left[ \frac{21070}{1.8 - 0.7525} - 5110 \right] \Omega = 15K\Omega$$

DNT can also be programmed by apply a voltage between the TRIM and GND pins (Figure 29). The following equation can be used to determine the value of Vtrim needed for a desired output voltage Vo:

$$V_{trim} = 0.7 - 0.1698 \times (V_o - 0.7525)$$

For example, to program the output voltage of a DNT module to 3.3 Vdc, Vtrim is calculated as follows

$$V_{trim} = 0.7 - 0.1698 \times (3.3 - 0.7525) = 0.267V$$

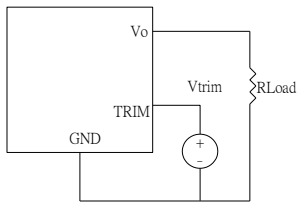


**Figure28:** Circuit configuration for programming output voltage using an external resistor





## FEATURE DESCRIPTIONS (CON.)

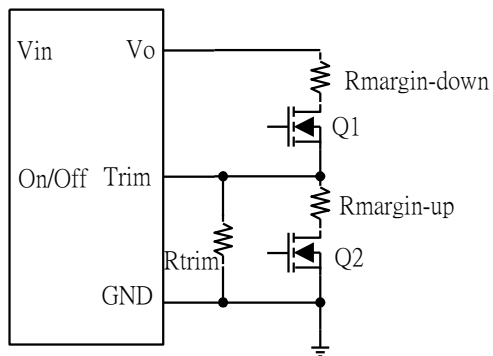


**Figure 29:** Circuit Configuration for programming output voltage using external voltage source

The amount of power delivered by the module is the voltage at the output terminals multiplied by the output current. When using the trim feature, the output voltage of the module can be increased, which at the same output current would increase the power output of the module. Care should be taken to ensure that the maximum output power of the module must not exceed the maximum rated power ( $V_{o.set} \times I_{o.max} \leq P_{max}$ ).

### Voltage Margining

Output voltage margining can be implemented in the DNT modules by connecting a resistor,  $R_{margin-up}$ , from the Trim pin to the ground pin for margining-up the output voltage and by connecting a resistor,  $R_{margin-down}$ , from the Trim pin to the output pin for margining-down. Figure 30 shows the circuit configuration for output voltage margining. If unused, leave the trim pin unconnected. A calculation tool is available from the evaluation procedure which computes the values of  $R_{margin-up}$  and  $R_{margin-down}$  for a specific output voltage and margin percentage.



**Figure 30:** Circuit configuration for output voltage margining



## THERMAL CONSIDERATIONS

Thermal management is an important part of the system design. To ensure proper, reliable operation, sufficient cooling of the power module is needed over the entire temperature range of the module. Convection cooling is usually the dominant mode of heat transfer.

Hence, the choice of equipment to characterize the thermal performance of the power module is a wind tunnel.

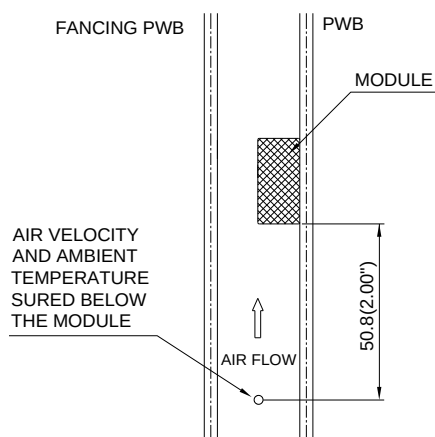
### Thermal Testing Setup

Delta's DC/DC power modules are characterized in heated vertical wind tunnels that simulate the thermal environments encountered in most electronics equipment. This type of equipment commonly uses vertically mounted circuit cards in cabinet racks in which the power modules are mounted.

The following figure shows the wind tunnel characterization setup. The power module is mounted on a test PWB and is vertically positioned within the wind tunnel. The height of this fan duct is constantly kept at 25.4mm (1").

### Thermal Derating

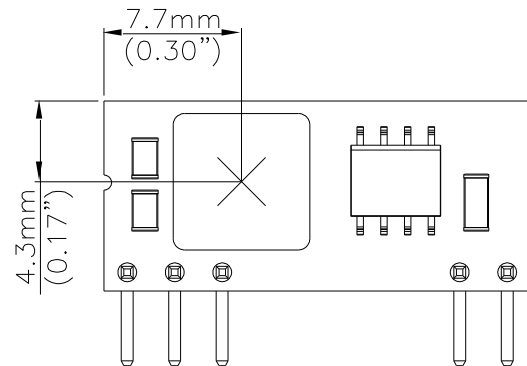
Heat can be removed by increasing airflow over the module. To enhance system reliability, the power module should always be operated below the maximum operating temperature. If the temperature exceeds the maximum module temperature, reliability of the unit may be affected.



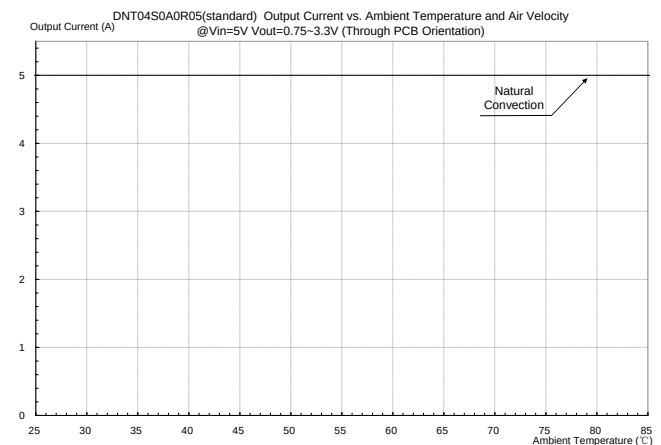
Note: Wind Tunnel Test Setup Figure Dimensions are in millimeters and (Inches)

**Figure 31:** Wind tunnel test setup

## THERMAL CURVES

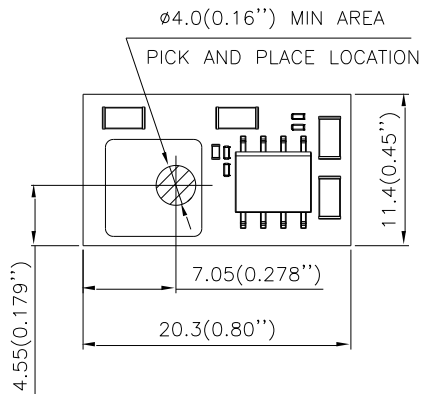


**Figure 32:** Temperature measurement location  
The allowed maximum hot spot temperature is defined at 125 °C



**Figure 33:** Output current vs. ambient temperature and air velocity @ Vin=5V, Vout=0.75V~3.3V(Through PCB Orientation)

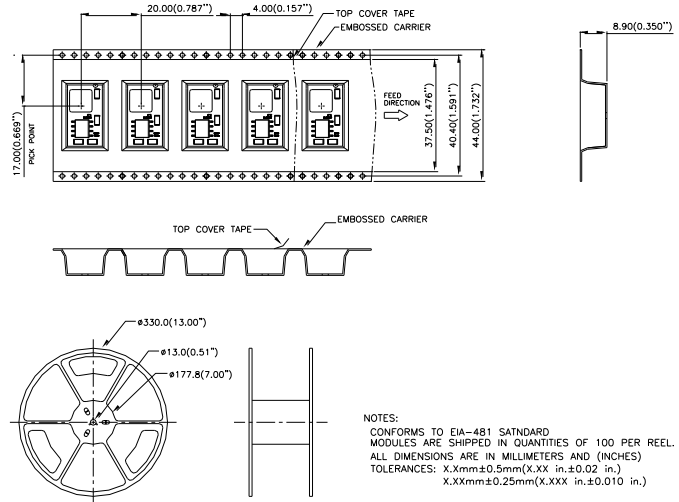
## PICK AND PLACE LOCATION



### NOTES:

ALL DIMENSIONS ARE IN MILLIMETERS AND (INCHES)  
 TOLERANCES: X.Xmm $\pm$ 0.5mm(X.XX in. $\pm$ 0.02 in.)  
 X.XXmm $\pm$ 0.25mm(X.XXX in. $\pm$ 0.010 in.)

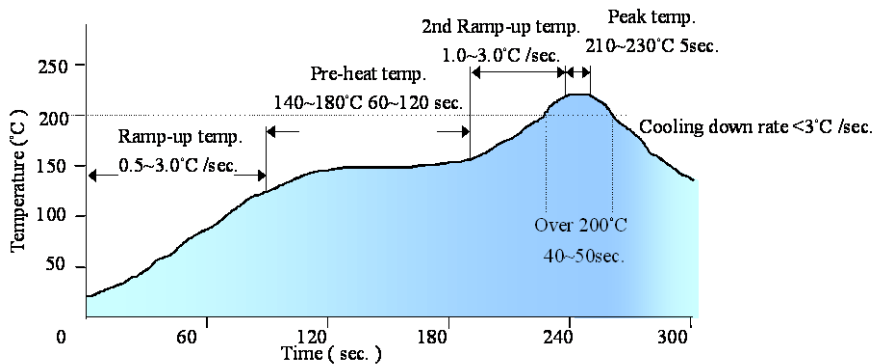
## SURFACE- MOUNT TAPE & REEL



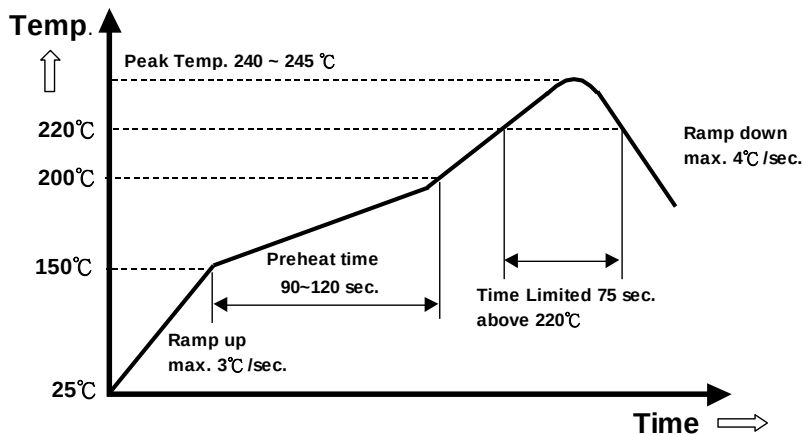
### NOTES:

CONFORMS TO EIA-481 STANDARD  
 MODULES ARE SHIPPED IN QUANTITIES OF 100 PER REEL.  
 ALL DIMENSIONS ARE IN MILLIMETERS AND (INCHES)  
 TOLERANCES: X.Xmm $\pm$ 0.5mm(X.XX in. $\pm$ 0.02 in.)  
 X.XXmm $\pm$ 0.25mm(X.XXX in. $\pm$ 0.010 in.)

## LEAD (Sn/Pb) PROCESS RECOMMEND TEMP. PROFILE



## LEAD FREE (SAC) PROCESS RECOMMEND TEMP. PROFILE

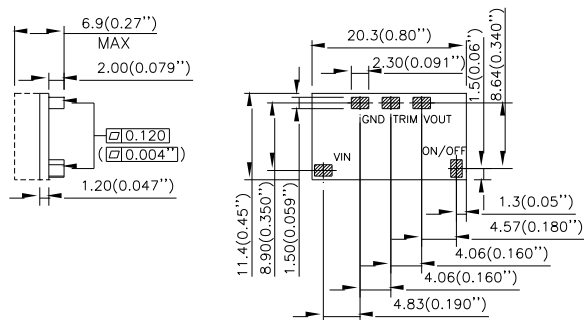


**Note:** All temperature refers to assembly application board, measured on the land of assembly application board.



## MECHANICAL DRAWING

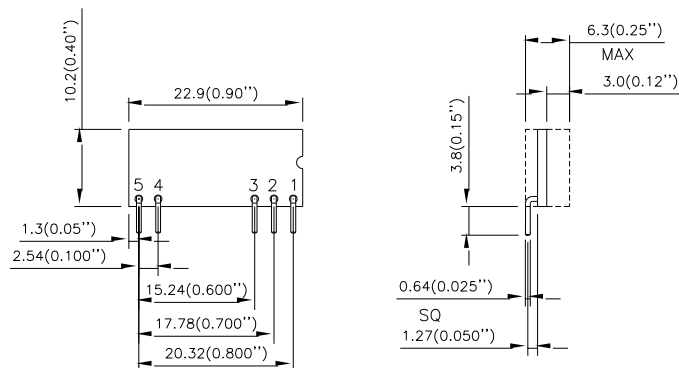
### SMD PACKAGE (OPTIONAL)



SIDE VIEW

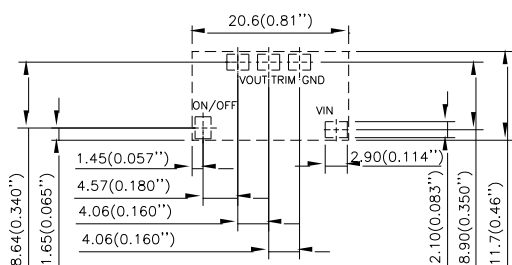
BOTTOM VIEW

### SIP PACKAGE

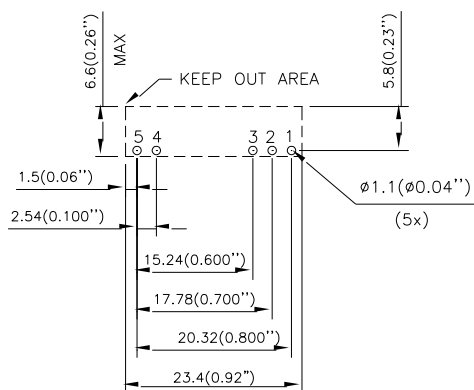


BACK VIEW

SIDE VIEW



RECOMMEND PWB PAD LAYOUT



RECOMMEND PWB PAD LAYOUT

| PIN# | FUNCTION |
|------|----------|
| 1    | Vout     |
| 2    | TRIM     |
| 3    | GND      |
| 4    | Vin      |
| 5    | On/Off   |

#### NOTES:

DIMENSIONS ARE IN MILLIMETERS AND (INCHES)

TOLERANCES: X.Xmm±0.5mm(X.XX in.±0.02 in.)

X.XXmm±0.25mm(X.XXX in.±0.010 in.)

Note: All pins are copper alloy with matte tin(Pb free) plated over Nickel under-plating.



## PART NUMBERING SYSTEM

| DNT            | 04             | S                  | 0A0                | R                 | 05             | N                                    | F                       | A                     |
|----------------|----------------|--------------------|--------------------|-------------------|----------------|--------------------------------------|-------------------------|-----------------------|
| Product Series | Input Voltage  | Numbers of Outputs | Output Voltage     | Package Type      | Output Current | On/Off logic                         |                         | Option Code           |
| DNT- 3A/5A     | 04 - 2.4V~5.5V | S - Single         | 0A0 - Programmable | R - SIP<br>S- SMD | 05 - 5A        | N- negative (Default)<br>P- positive | F- RoHS 6/6 (Lead Free) | A - Standard Function |

## MODEL LIST

| Model Name      | Package | Input Voltage | Output Voltage  | Output Current | Efficiency<br>5Vin, 3.3Vdc full load |
|-----------------|---------|---------------|-----------------|----------------|--------------------------------------|
| DNT04S0A0S03NFA | SMD     | 2.4V ~ 5.5Vdc | 0.75V ~ 3.63Vdc | 3A             | 93.5%                                |
| DNT04S0A0R03NFA | SIP     | 2.4V ~ 5.5Vdc | 0.75V ~ 3.63Vdc | 3A             | 94%                                  |
| DNT04S0A0S05NFA | SMD     | 2.4V ~ 5.5Vdc | 0.75V ~ 3.63Vdc | 5A             | 94%                                  |
| DNT04S0A0R05NFA | SIP     | 2.4V ~ 5.5Vdc | 0.75V ~ 3.63Vdc | 5A             | 93%                                  |

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