DELPHI SERIES

FEATURES

- High efficiency: 97% @ 24Vin, 12V/6A out
- Small size and low profile: (SIP) 50.8 x 12.7 x 9.5mm (2.00" x 0.50" x 0.37")
- Standard footprint
- Voltage and resistor-based trim
- Pre-bias startup
- No minimum load required
- Output voltage programmable from 5Vdc to 15Vdc via external resistor
- Fixed frequency operation (300KHz)
- Input UVLO, output OTP, OCP
- Remote ON/OFF
- Remote sense
- ISO 9001, TL 9000, ISO 14001, QS9000, OHSAS18001 certified manufacturing facility
- UL/cUL 60950-1 (US & Canada), and TUV (EN60950-1) - pending

Delphi DNM24 series Non-Isolated Point of Load DC/DC Power Modules: 20-30Vin, 5-15V/10A out

The Delphi series DNM24S, 20~30V 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 DNM24S series provides a programmable output voltage from 5V to 15V through an external trimming resistor. This product family is available in SIP package and provides 10A of output current in an industry standard footprint and pinout. With creative design technology and optimization of component placement, these converters possess outstanding electrical and thermal performance and extremely high reliability under highly stressful operating conditions.

OPTIONS

- Negative On/Off logic

APPLICATIONS

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

PRELIMINARY DATASHEET
DS_DNM24SIP10_08142008

Delta Electronics, Inc.

TECHNICAL SPECIFICATIONS

T_A = 25°C, airflow rate = 300 LFM, V_{in} = 20Vdc and 30Vdc, nominal Vout unless otherwise noted.

PARAMETER	NOTES and CONDITIONS	DNM24S0B0R10NFB			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage (Continuous)		0		36	Vdc
Operating Temperature	Refer to Figure 27 for the measuring point	-40		125	°C
Storage Temperature		-55		125	°C
INPUT CHARACTERISTICS					
Operating Input Voltage		20	24	30	V
Input Under-Voltage Lockout					
Turn-On Voltage Threshold				19	V
Turn-Off Voltage Threshold		17			V
Maximum Input Current	Vin=Vin,min to Vin,max, Io=6A,Vo=12V			4.5	A
No-Load Input Current	Vin=24V, Io=Min Load, Vo=12V		70		mA
Off Converter Input Current	Vin=24V, Off Converter			3	mA
Inrush Transient	Vin= Vin,min to Vin,max, Io=Io,min to Io,max			1	A^2S
Recommended Input Fuse				15	A
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=24V, Io=Io,max	-2.0	Vo,set	+2.0	% Vo,set
Output Voltage Adjustable Range		5		15	V
Output Voltage Regulation					
Over Line	Vin=Vin,min to Vin,max			0.4	% Vo,set
Over Load	Io=Io,min to Io,max			0.4	% Vo,set
Over Temperature	Ta= -40℃ to 85℃		0.5	1	% Vo,set
Total Output Voltage Range	Over sample load, line and temperature	-3		+3	% Vo,set
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
Peak-to-Peak	Vin=min to max, Io=min to max1µF ceramic, 10µF Tan		80	160	mV
RMS	Vin=min to max, Io=min to max1µF ceramic, 10µF Tan		30	60	mV
Output Current Range	Vin=24V, Vo=5V	0		10	A
	Vin=24V, Vo=12V	0		6	A
	Vin=24V, Vo=15V	0		4.5	A
Output Voltage Over-shoot at Start-up	Vin=min to max, Io=Io,max			3	% Vo,set
Output Short-Circuit Current (Hiccup mode)	Io,s/c		20		Adc
DYNAMIC CHARACTERISTICS					
Dynamic Load Response	10µF Tan & 1µF ceramic load cap, 5A/µs,Vin=24V ,Vo=12V, Io, max=6A, no external out capacitor				
Positive Step Change in Output Current	50% Io, max to 100% Io, max		280		mVpk
Negative Step Change in Output Current	100% Io, max to 50% Io, max		280		mVpk
Settling Time to 10% of Peak Devitation			50		µs
Dynamic Load Response	10µF Tan & 1µF ceramic load cap, 5A/µs, Vin=24V Vo=12V, Io, max=6A, 2x150uF OS-CON capacitor				
Positive Step Change in Output Current	50% Io, max to 100% Io, max		130		mVpk
Negative Step Change in Output Current	100% Io, max to 50% Io, max		130		mVpk
Settling Time to 10% of Peak Devitation			50		µs
Turn-On Transient	Io=Io.max				
Start-Up Time, From On/Off Control	Von/off, Vo=10% of Vo,set	2	4	8	ms
Start-Up Time, From Input	Vin=Vin,min, Vo=10% of Vo,set	2	4	8	ms
Output Voltage Rise Time	Time for Vo to rise from 10% to 90% of Vo,set	2	5	9	ms
Maximum Output Startup Capacitive Load	Full load; ESR ≧1mΩ			1000	µF
	Full load; ESR ≧10mΩ			2000	µF
EFFICIENCY					
Vo=5V	Vin=24V, Io=Io,max		93.0		%
Vo=12V	Vin=24V, Io=Io,max		97.0		%
Vo=15V	Vin=24V, Io=Io,max		97.0		%
FEATURE CHARACTERISTICS					
Switching Frequency			300		kHz
ON/OFF Control, (Negative logic)					
Logic Low Voltage	Module On, Von/off	-0.3		1.2	V
Logic High Voltage	Module Off, Von/off	2.5		Vin,max	V
Logic Low Current	Module On, Ion/off		10	30	uA
Logic High Current	Module Off, Ion/off			1	mA
ON/OFF Control, (Positive Logic)					
Logic High Voltage	Module On, Von/off	Vin-2.5		Vin,max	V
Logic Low Voltage	Module Off, Von/off	-0.3		1.2	V
Logic High Current	Module On, Ion/off		10	30	uA
Logic Low Current	Module Off, Ion/off			1	mA
Remote Sense Range				0.5	V
GENERAL SPECIFICATIONS					
MTBF	Io=Io,max, Ta=25℃		TBD		M hours
Weight			12		grams
Over-Temperature Shutdown	Refer to Figure 27 for the measuring point		125		°C

ELECTRICAL CHARACTERISTICS CURVES

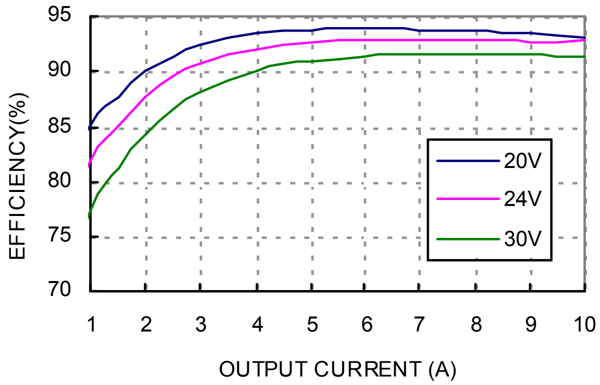


Figure 1: *Converter efficiency vs. output current (5.0V output voltage)*

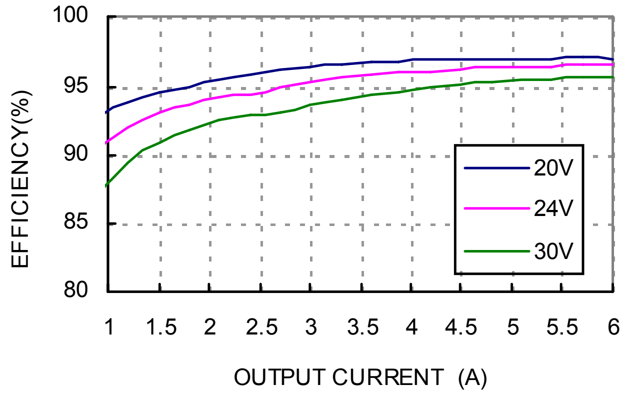


Figure 2: *Converter efficiency vs. output current (12V output voltage)*

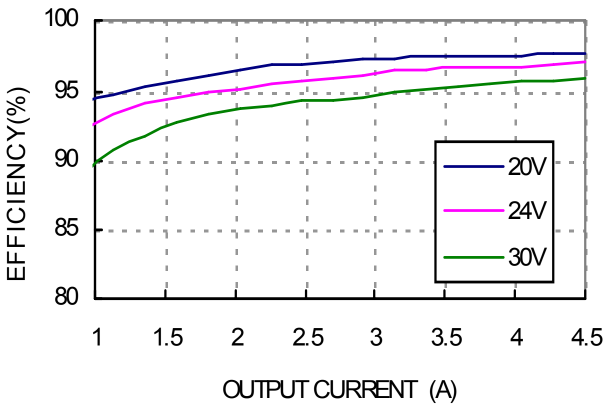


Figure 3: *Converter efficiency vs. output current (15V output voltage)*

ELECTRICAL CHARACTERISTICS CURVES

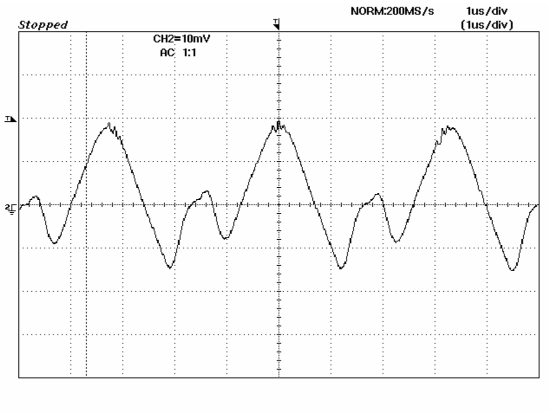


Figure 4: *Output ripple & noise at 24Vin, 5.0V/10A out*

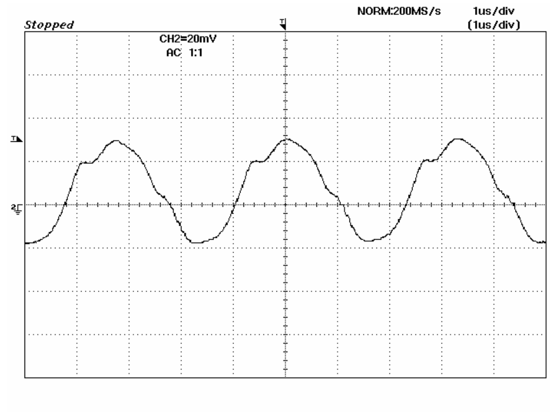


Figure 5: *Output ripple & noise at 24Vin, 12V/6A out*

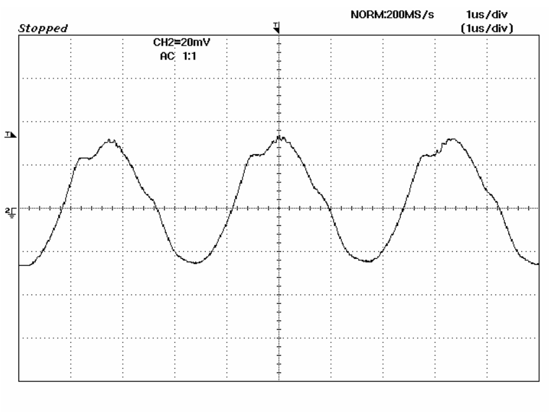


Figure 6: *Output ripple & noise at 24Vin, 15V/4.5A out*

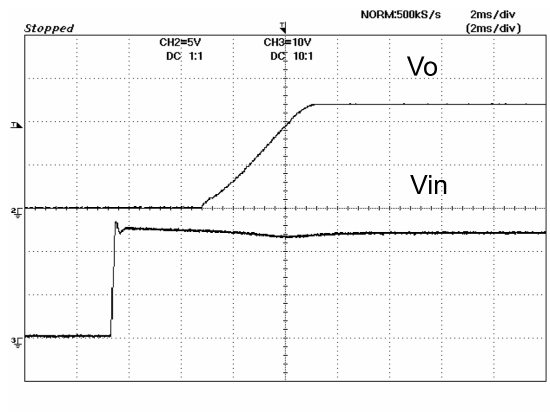


Figure 7: *Turn on delay time at 24vin, 12V/6A out*

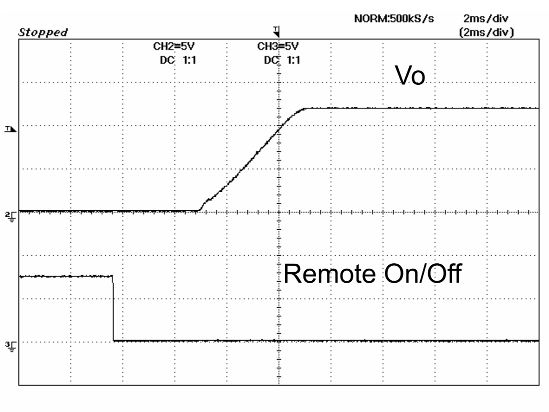


Figure 8: *Turn on delay time at Remote On/Off,12V/6A out*

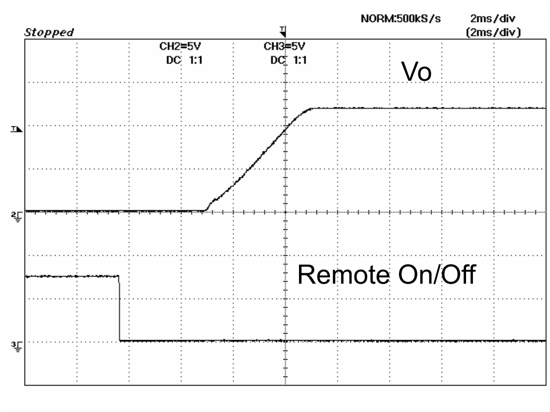


Figure 9: *Turn on Using Remote On/Off with external capacitors (Co= 2000 µF), 12V/6A out*

ELECTRICAL CHARACTERISTICS CURVES

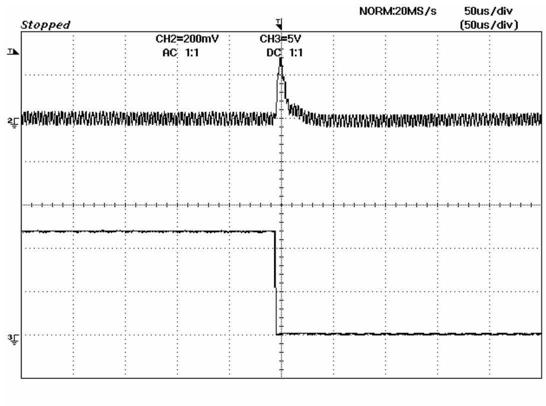


Figure 10: *Typical transient response to step load change at 5A/µS from 100% to 50% of Io, max at 24Vin, 12.0V out (Cout = 1uF ceramic, 10µF tantalum)*

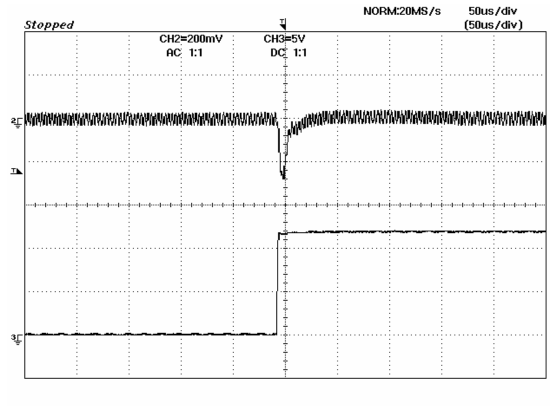


Figure 11: *Typical transient response to step load change at 5A/µS from 50% to 100% of Io, max at 24Vin, 12.0V out (Cout = 1uF ceramic, 10µF tantalum)*

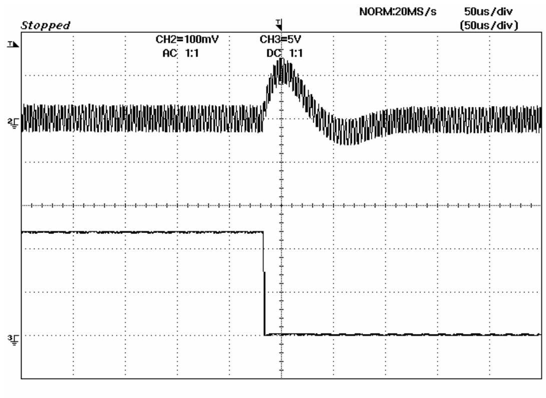


Figure 12: *Typical transient response to step load change at 5A/µS from 100% to 50% of Io, max at 24Vin, 12.0Vout (Cout = 1uF ceramic, 10µF tantalum) with external 2*150uF OS-CON capacitors*

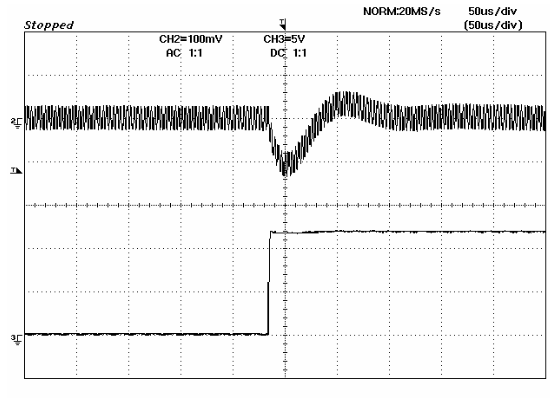


Figure 13: *Typical transient response to step load change at 5A/µS from 50% to 100% of Io, max at 24Vin, 12.0Vout (Cout = 1uF ceramic, 10µF tantalum) with external 2*150uF OS-CON capacitors*

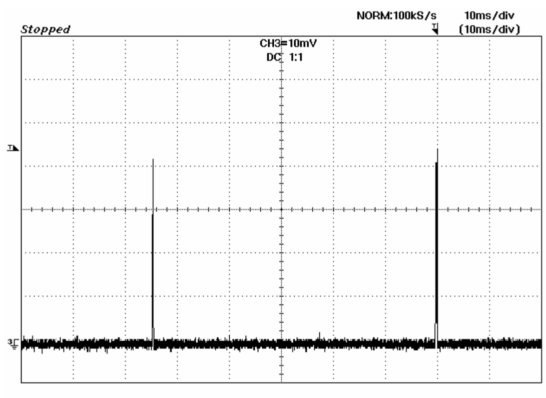


Figure 14: *Output short circuit current 24Vin, 5.0Vout (20A/div)*

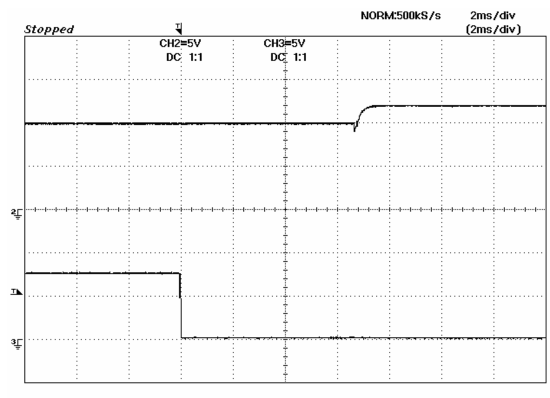
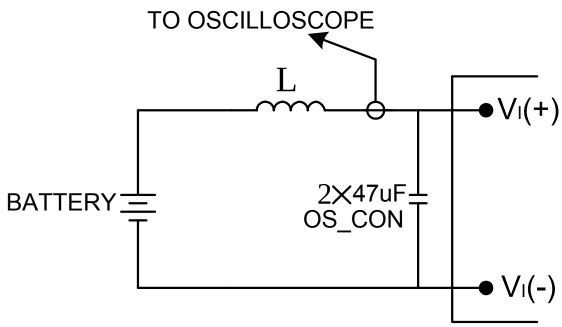


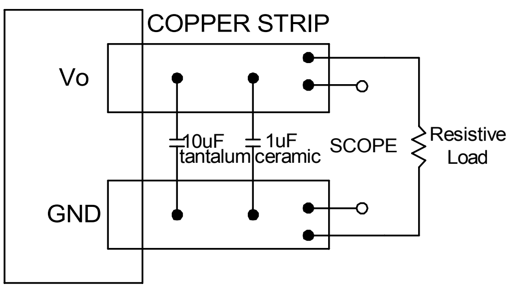
Figure 15: *Turn on with Prebias 24Vin, 12V/0A out, Vbias =10.2Vdc*

TEST CONFIGURATIONS



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

Figure 16: *Input reflected-ripple test setup*



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

Figure 17: *Peak-peak output noise and startup transient measurement test setup*

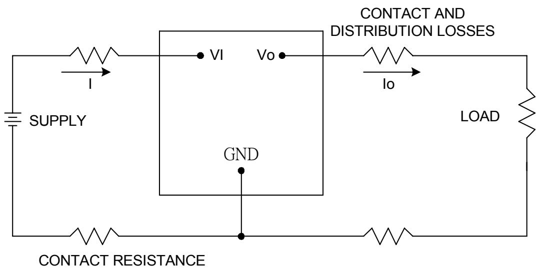


Figure 18: *Output voltage and efficiency measurement test setup*

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.

$$\eta = \left(\frac{Vo \times Io}{Vi \times Ii}\right) \times 100 \quad \%$$

DESIGN CONSIDERATIONS

Input Source Impedance

To maintain low-noise and ripple at the input voltage, it Is critical to use low ESR capacitors at the input to the module. Figure 19 shows the input ripple voltage (mVp-p) for various output models using 2x47 uF low ESR OS-CON capacitors (SANYO P/N:35SVPD47M, 47uF/35V or equivalent).
The input capacitance should be able to handle an AC Ripple current of at least:

$$Irms = Iout\sqrt{\frac{Vout}{Vin}\left(1 - \frac{Vout}{Vin}\right)} \quad Arms$$

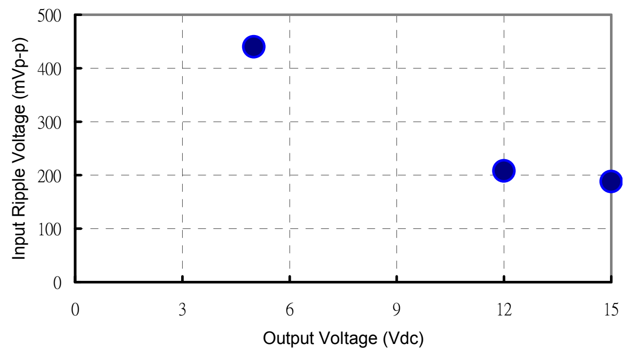


Figure 19: *Input ripple voltage for various Output models, Vo=5V Io = 10A 、Vo=12V Io = 6A and Vo=15V Io = 4.5A (Cin = 2x47uF OS-CON capacitors at the input)*

DESIGN CONSIDERATIONS (CON.)

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 maximum 15A of glass type fast-acting fuse in the ungrounded lead.

FEATURES DESCRIPTIONS

Remote On/Off

The DNM 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 DNM 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 20). 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 21) 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, leave the pin floating or tie to GND. (module will be On)

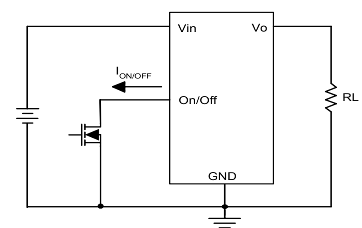


Figure 20: *Positive remote On/Off implementation*

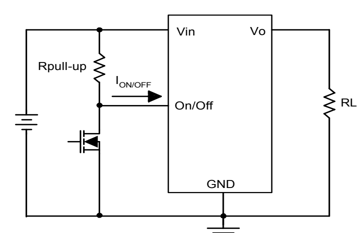


Figure 21: *Negative remote On/Off implementation*

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.

Over-Temperature Protection

The over-temperature protection consists of circuitry that provides protection from thermal damage. If the temperature exceeds the over-temperature threshold the module will shut down. The module will try to restart after shutdown. If the over-temperature condition still exists during restart, the module will shut down again. This restart trial will continue until the temperature is within specification

Remote Sense

The DNM provide Vo remote sensing to achieve proper regulation at the load points and reduce effects of distribution losses on output line. In the event of an open remote sense line, the module shall maintain local sense regulation through an internal resistor. The module shall correct for a total of 0.1V of loss. The remote sense line impedance shall be < 10Ω.

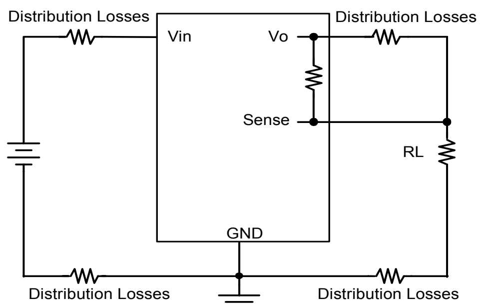


Figure 22: *Effective circuit configuration for remote sense operation*

Output Voltage Programming

The output voltage of the DNM can be programmed to any voltage between 5.021Vdc and 15.0Vdc by connecting one resistor (shown as Rtrim in Figure 23) between the TRIM and GND pins of the module. Without this external resistor, the output voltage of the module is 5.021 Vdc. To calculate the value of the resistor Rtrim for a particular output voltage Vo, please use the following equation:

$$\mathrm{Rtrim} = \left(\frac{10500}{\mathrm{Vo} - 5.021} - 1000 \right) \cdot \Omega$$

Rtrim is the external resistor in Ω
Vo is the desired output voltage

For example, to program the output voltage of the DNM module to12Vdc, Rtrim is calculated as follows:

$$\mathrm{Rtrim} = \left(\frac{10500}{6.979} - 1000 \right) \cdot \Omega$$

Rtrim = 504.514Ω

DNM can also be programmed by applying a voltage between the TRIM and GND pins (Figure 24). The following equation can be used to determine the value of Vtrim needed for a desired output voltage Vo:

$$\mathrm{Vtrim} = 0.7 - [(\mathrm{Vo} - 5.021) \cdot 0.0667]$$

Vtrim is the external voltage in V
Vo is the desired output voltage

For example, to program the output voltage of a DNM module to 12 Vdc, Vtrim is calculated as follows

$$\mathrm{Vtrim} = 0.7 - (6.979 \cdot 0.0667)$$

Vtrim = 0.2345V

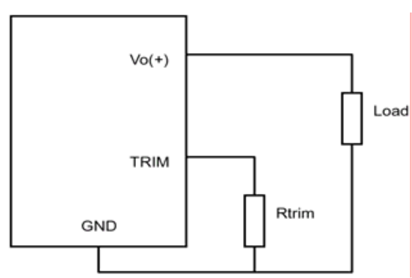


Figure 23: *Circuit configuration for programming output voltage using an external resistor*

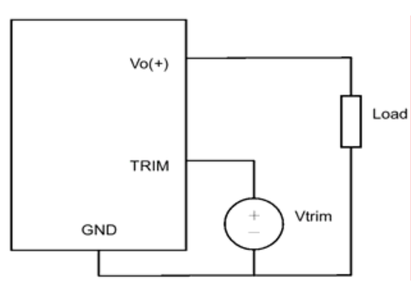


Figure 24: *Circuit Configuration for programming output voltage using external voltage source*

FEATURE DESCRIPTIONS (CON.)

Table 1 provides Rtrim values required for some common output voltages, while Table 2 provides value of external voltage source, Vtrim, for the same common output voltages. By using a ±0.5% tolerance trim resistor, set point tolerance of ±2% can be achieved as specified in the electrical specification.

Table 1

VO (V)	Rtrim (Ω)
5.021	Open
12	504.514
15	52.21

Table 2

VO (V)	Vtrim (V)
5.021	Open
12	0.2345
15	0.0344

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 DNM modules by connecting a resistor, $R_{margin\text{-}up}$, from the Trim pin to the ground pin for margining-up the output voltage and by connecting a resistor, $R_{margin\text{-}down}$, from the Trim pin to the output pin for margining-down. Figure 25 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 $R_{margin\text{-}up}$ and $R_{margin\text{-}down}$ for a specific output voltage and margin percentage.

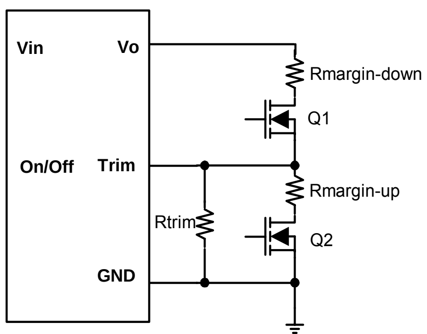


Figure 25: *Circuit configuration for output voltage margining*

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.

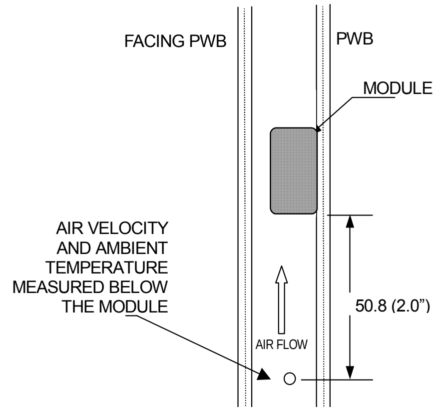
Thermal Testing Setup

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 De-rating

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 26: *Wind tunnel test setup*

THERMAL CURVES

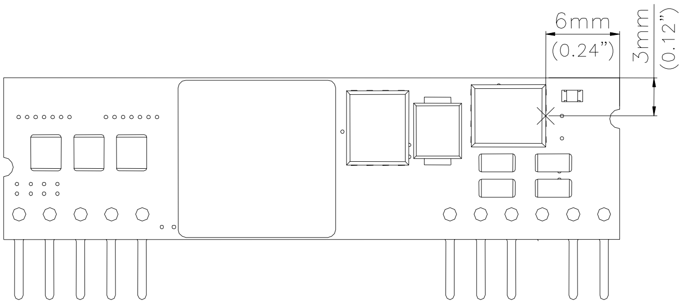


Figure 27: *Temperature measurement location*
The allowed maximum hot spot temperature is defined at 125℃

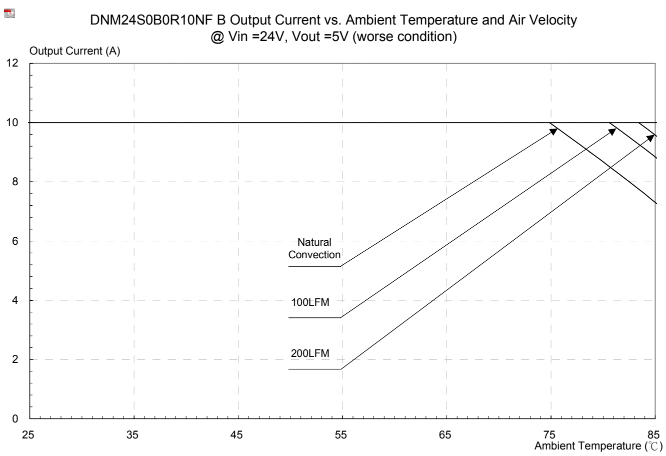


Figure 28: *Output current vs. ambient temperature and air velocity@ Vin=24V, Vo=5.0V(Either Orientation)*

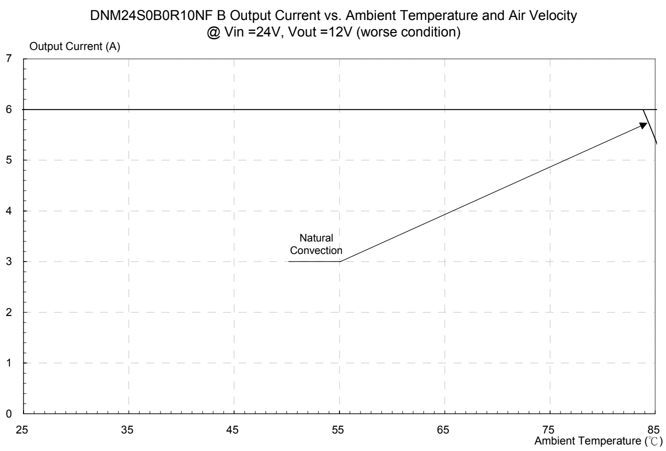


Figure 29: *Output current vs. ambient temperature and air velocity@ Vin=24V, Vo=12V(Either Orientation)*

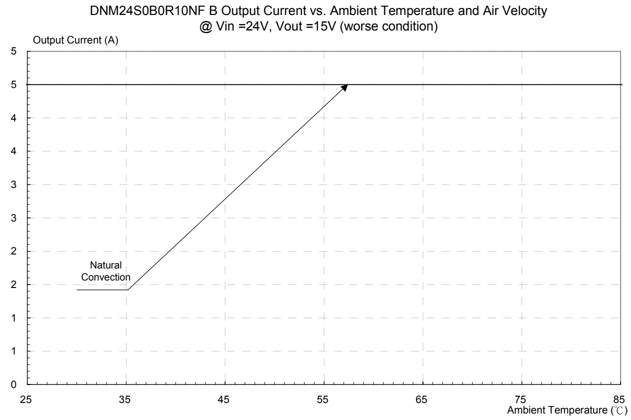
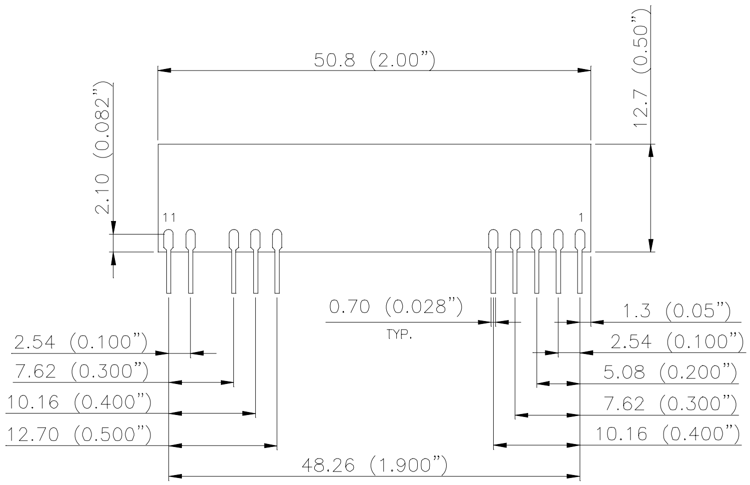
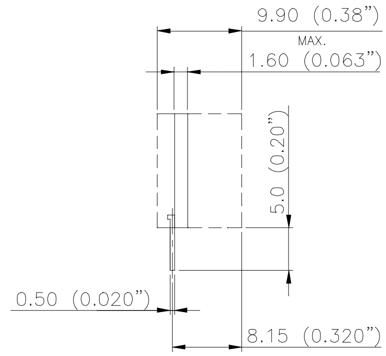


Figure 30: *Output current vs. ambient temperature and air velocity@ Vin=24V, Vo=15V(Either Orientation)*

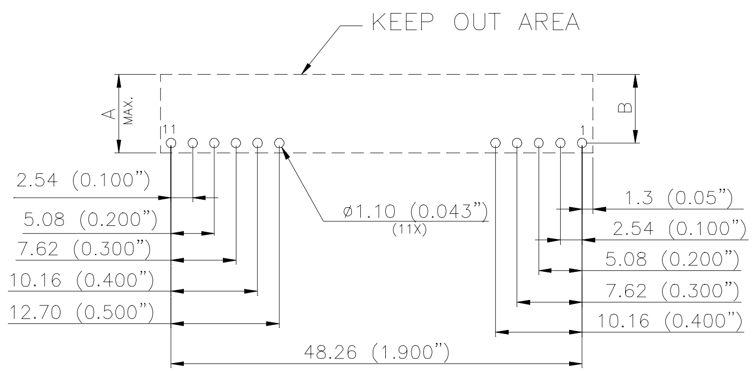
SIP PACKAGE



BACK VIEW



SIDE VIEW



A	B
9.9 (0.38")	8.15 (0.320")

PIN#	Function
1	Vo
2	Vo
3	Vo SENSE
4	Vo
5	GND
6	GND
7	Vi
8	Vi
9	No Pin
10	TRIM
11	ON/OFF

RECOMMENDED P.W.B LAYOUT

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.)

PART NUMBERING SYSTEM

DNM	24	S	0B0	R	10	N	F	B
Product Series	Input Voltage	Numbers of Outputs	Output Voltage	Package Type	Output Current	On/Off logic		Option Code
DNM ~ 10A	24 - 20~30V	S - Single	0B0 - Programmable	R - SIP	10 -10A	N- negative P- positive	F- RoHS 6/6 (Lead Free)	B - No tracking pin

MODEL LIST

Model Name	Packaging	Input Voltage	Output Voltage	Output Current	On/Off logic	Efficiency 24Vin @ 100% load
DNM24S0B0R10NFB	SIP	20V ~ 30V	5.0V ~ 15.0V	4.5A~10A	Negative	97% (12V/6A)

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WARRANTY

Delta offers a two (2) year limited warranty. Complete warranty information is listed on our web site or is available upon request from Delta.