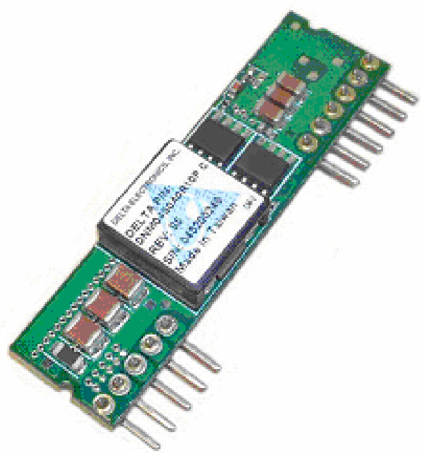
DELPHI SERIES



FEATURES

- High efficiency: 93.5% @ 12Vin, 5V/20A 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
- Output voltage tracking
- No minimum load required
- Output voltage programmable from 0.75Vdc to 5Vdc via external resistor
- Fixed frequency operation (300KHz)
- Input UVLO, output OTP, OCP
- Remote ON/OFF(default:positive)
- Remote sense
- ISO 9001, TL 9000, ISO 14001, QS 9000, OHSAS 18001 certified manufacturing facility
- UL/cUL 60950-1 (US & Canada), and TUV (EN60950-1) - pending

Delphi DNL, Non-Isolated Point of Load DC/DC Power Modules: 8.3-14Vin, 0.75-5.0V/20A out

The Delphi series DNL, 8.3~14V 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 DNL series provides a programmable output voltage from 0.75V to 5.0V through an external trimming resistor. The DNL converters have flexible and programmable tracking and sequencing features to enable a variety of sequencing and tracking between several point of load power modules. This product family is available in a surface mount or SIP package and provides up to 20A 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_DNL10SIP20_10132008

Delta Electronics, Inc.

TECHNICAL SPECIFICATIONS

T_A = 25°C, airflow rate = 300 LFM, V_{in} = 8.3Vdc and 14Vdc, nominal Vout unless otherwise noted.

PARAMETER	NOTES and CONDITIONS	DNL10S0A0R20			
		Min.	Typ.	Max.	Units
ABSOLUTE MAXIMUM RATINGS					
Input Voltage (Continuous)		0		15	Vdc
Tracking Voltage		0		Vin,max	Vdc
Operating Temperature	Refer to Figure 41 for the measuring point	-40		+120	°C
Storage Temperature		-55		+125	°C
INPUT CHARACTERISTICS					
Operating Input Voltage	Vo,set≦3.63Vdc	8.3	12	14	V
	Vo,set＞3.63Vdc	8.3	12	13.2	V
Input Under-Voltage Lockout					
Turn-On Voltage Threshold			7.9		V
Turn-Off Voltage Threshold			7.8		V
Maximum Input Current	Vin=Vin,min to Vin,max, Io=Io,max			14.5	A
No-Load Input Current			100		mA
Off Converter Input Current			2		mA
Inrush Transient	Vin= Vin,min to Vin,max, Io=Io,min to Io,max			0.4	A^2S
Recommended Input Fuse				15	A
OUTPUT CHARACTERISTICS					
Output Voltage Set Point	Vin=12V, Io=Io,max	-2.0	Vo,set	+2.0	% Vo,set
Output Voltage Adjustable Range		0.7525		5	V
Output Voltage Regulation					
Over Line	Vin=Vin,min to Vin,max		0.3		% Vo,set
Over Load	Io=Io,min to Io,max		0.4		% Vo,set
Over Temperature	Ta= -40℃ to 85℃		0.4		% Vo,set
Total Output Voltage Range	Over sample load, line and temperature	-2.5		+3.5	% Vo,set
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth				
Peak-to-Peak	Vin=min to max, Io=min to max.1μF ceramic, 100uF ceramic		30	65	mV
RMS	Vin=min to max, Io=min to max.1μF ceramic, 100uF ceramic		10	20	mV
Output Current Range		0		20	A
Output Voltage Over-shoot at Start-up	Vout=3.3V			5	% Vo,set
Output DC Current-Limit Inception			150		% Io
Output Short-Circuit Current (Hiccup mode)	Io,s/c		3		Adc
DYNAMIC CHARACTERISTICS					
Dynamic Load Response	470uF poscap & 100μF+1uF ceramic load cap, 5A/μs,				
Positive Step Change in Output Current	50% Io, max to 100% Io, max		150		mVpk
Negative Step Change in Output Current	100% Io, max to 50% Io, max		150		mVpk
Settling Time (Vo < 10% Peak Deviation)			60		μs
Turn-On Transient	Io=Io.max				
Start-Up Time, From On/Off Control	Von/off, Vo=10% of Vo,set		5		ms
Start-Up Time, From Input	Vin=Vin,min, Vo=10% of Vo,set		5		ms
Output Voltage Rise Time	Time for Vo to rise from 10% to 90% of Vo,set		4	6	ms
Output Capacitive Load	Full load; ESR ≧**1mΩ**			1000	μF
	Full load; ESR ≧**10mΩ**, Vin<9.0V			3500	μF
	Full load; ESR ≧**10mΩ**, Vin≧9.0V			5000	μF
EFFICIENCY					
Vo=0.75V	Vin=12V, Io=Io,max		78.0		%
Vo=1.0V	Vin=12V, Io=Io,max		82.5		%
Vo=1.2V	Vin=12V, Io=Io,max		84.5		%
Vo=1.5V	Vin=12V, Io=Io,max		86.5		%
Vo=1.8V	Vin=12V, Io=Io,max		88.0		%
Vo=2.0V	Vin=12V, Io=Io,max		89.0		%
Vo=2.5V	Vin=12V, Io=Io,max		90.0		%
Vo=3.3V	Vin=12V, Io=Io,max		91.5		%
Vo=5.0V	Vin=12V, Io=Io,max		93.5		%
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	uA
Logic High Current	Module Off, Ion/off		0.2	1	mA
ON/OFF Control, (Positive Logic)					
Logic High Voltage	Module On, Von/off			Vin,max	V
Logic Low Voltage	Module Off, Von/off	-0.2		0.3	V
Logic High Current	Module On, Ion/off			10	uA
Logic Low Current	Module Off, Ion/off		0.2	1	mA
Tracking Slew Rate Capability		0.1		2	V/msec
Tracking Delay Time	Delay from Vin.min to application of tracking voltage	10			ms
Tracking Accuracy	Power-up, subject to 2V/mS		100	200	mV
	Power-down, subject to 1V/mS		200	400	mV
Remote Sense Range				0.1	V
GENERAL SPECIFICATIONS					
MTBF	Io=80%Io, max, Ta=25℃		TBD		M hours
Weight			12		grams
Over-Temperature Shutdown	Refer to Figure 41 for the measuring point		125		°C

ELECTRICAL CHARACTERISTICS CURVES

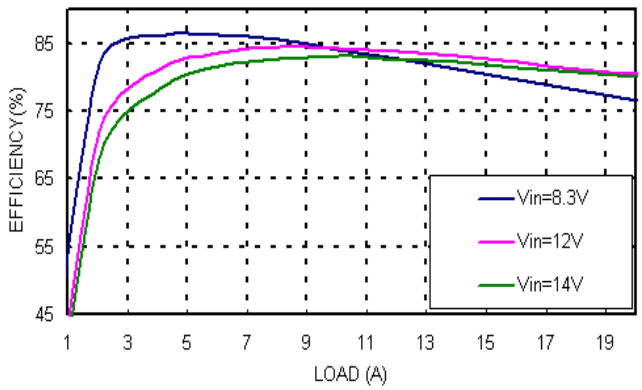


Figure 1: *Converter efficiency vs. output current (0.75V output voltage).*

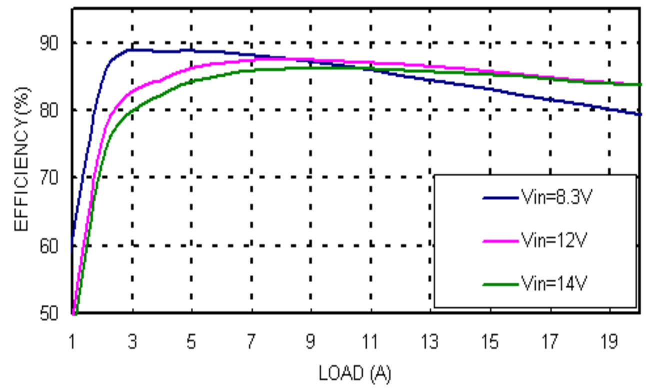


Figure 2: *Converter efficiency vs. output current (1.0V output voltage).*

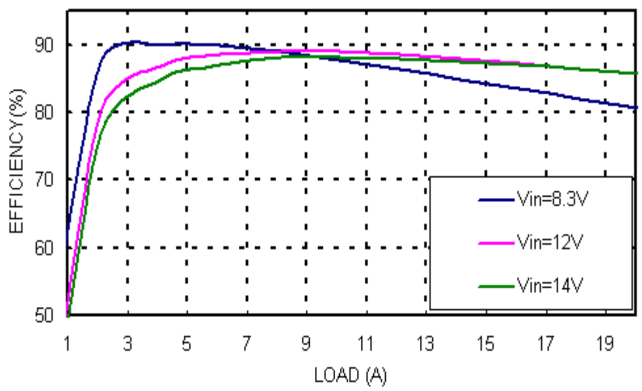


Figure 3: *Converter efficiency vs. output current (1.2V output voltage).*

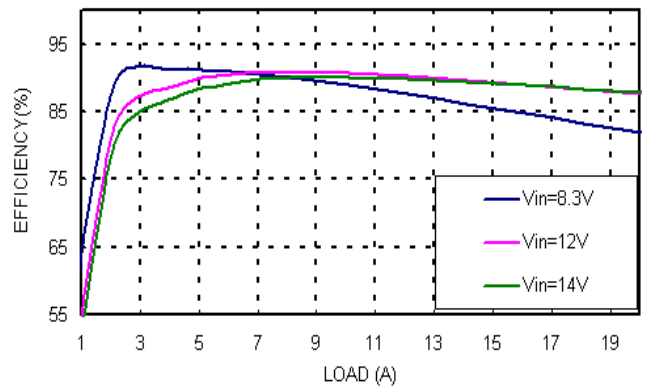


Figure 4: *Converter efficiency vs. output current (1.5V output voltage).*

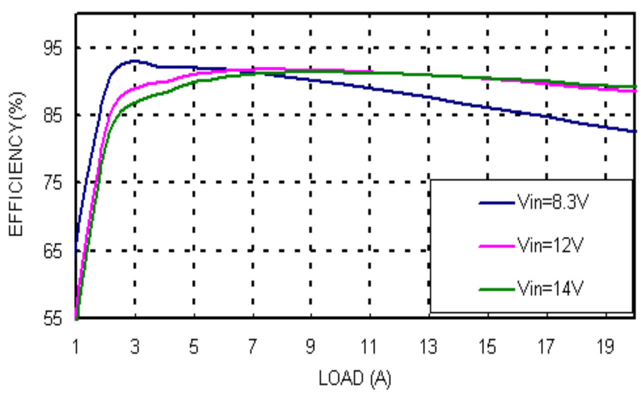


Figure 5: *Converter efficiency vs. output current (1.8V output voltage).*

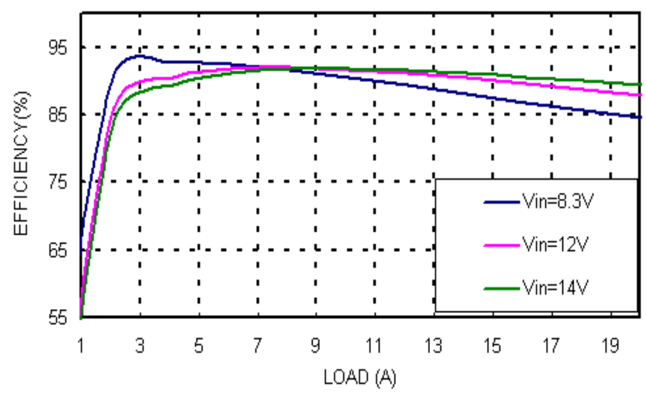


Figure 6: *Converter efficiency vs. output current (2V output voltage).*

ELECTRICAL CHARACTERISTICS CURVES

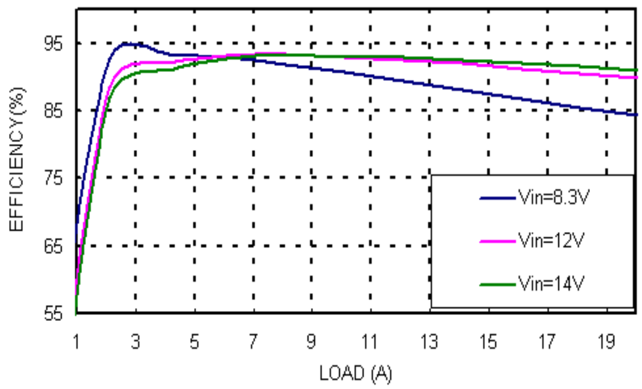


Figure 7: *Converter efficiency vs. output current (2.5V output voltage).*

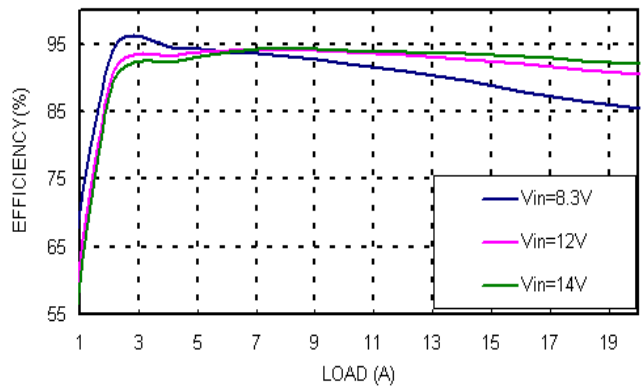


Figure 8: *Converter efficiency vs. output current (3.3V output voltage).*

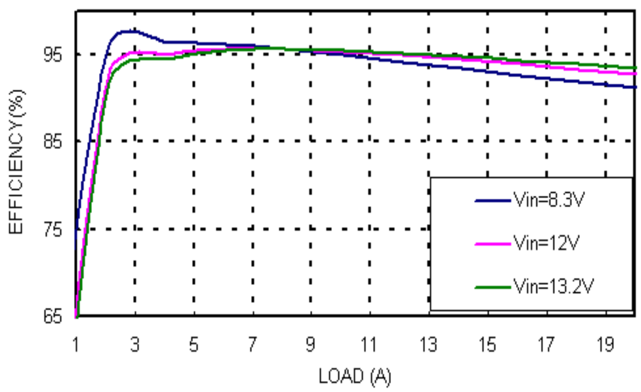


Figure 9: *Converter efficiency vs. output current (5.0V output voltage).*

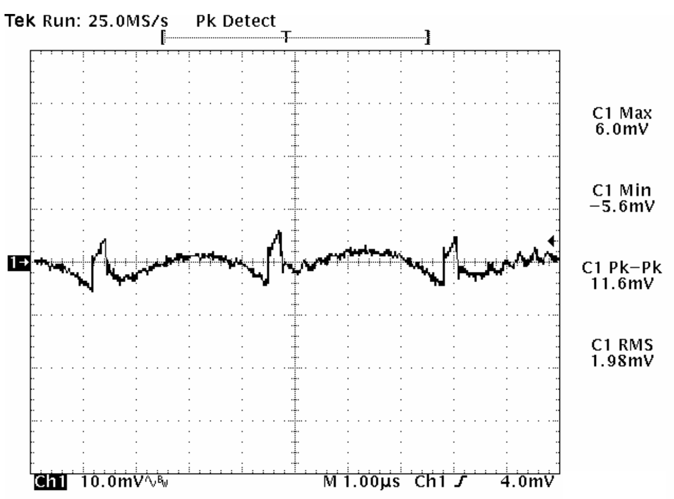


Figure 10: *Output ripple & noise at 12Vin, 0.75V/20A out.*

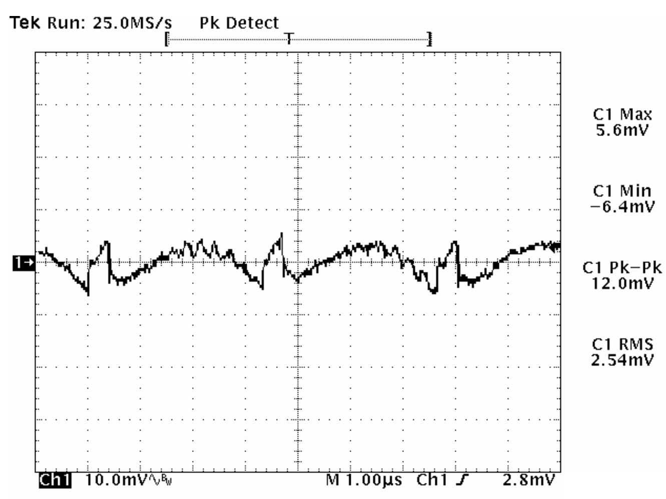


Figure 11: *Output ripple & noise at 12Vin, 1.2V/20A out.*

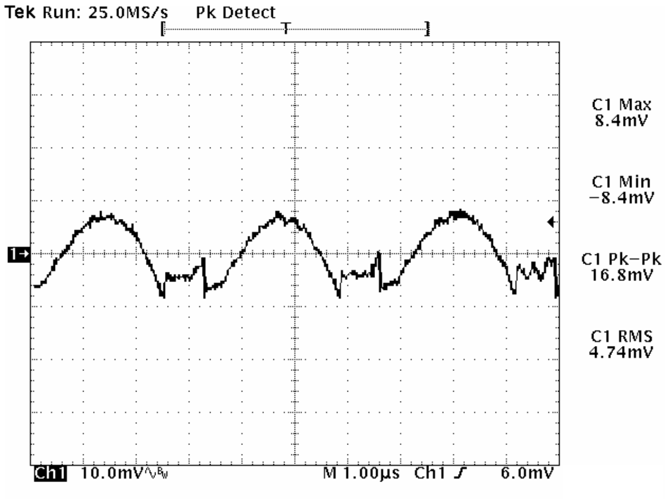


Figure 12: *Output ripple & noise at 12Vin, 2.5V/20A out.*

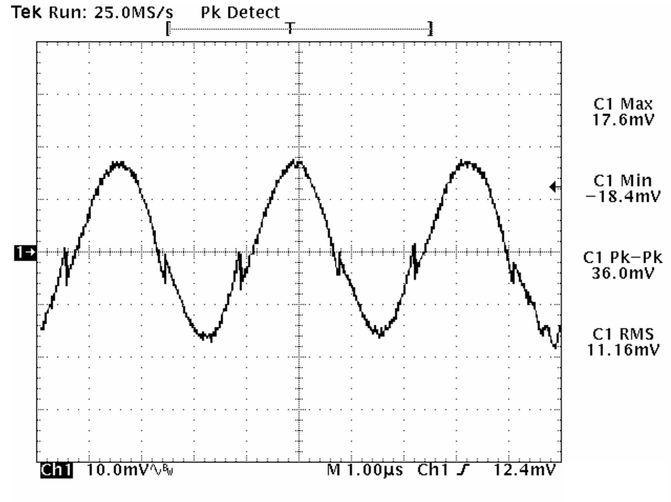


Figure 13: *Output ripple & noise at 12Vin, 5V/20A out.*

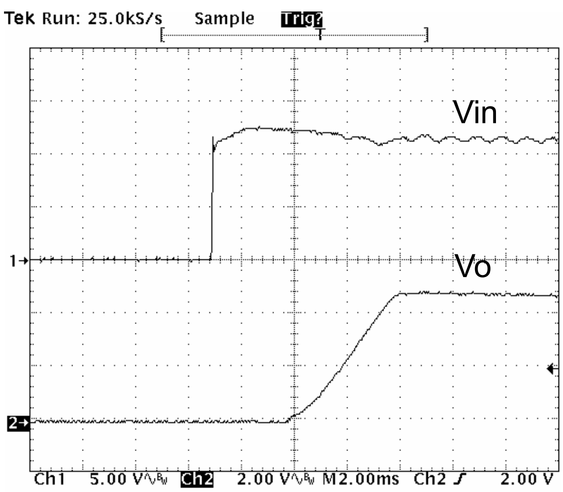


Figure 14: *Turn on delay time at 12vin, 5.0V/20A out.*

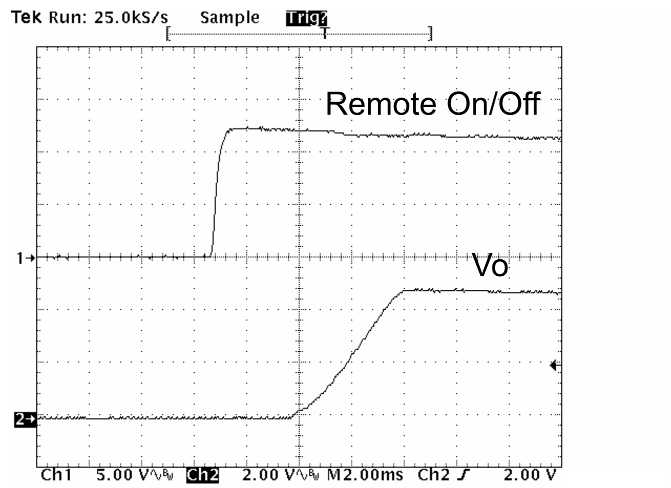


Figure 15: *Turn on delay time using Remote On/Off, at 12vin, 5.0V/20A out.*

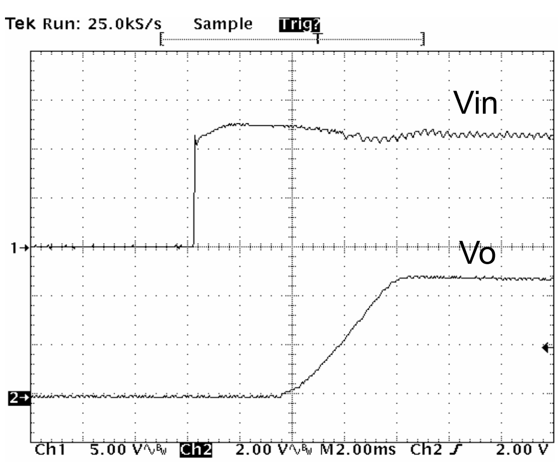


Figure 16: *Turn on delay with external capacitors (Co= 5000 µF), at 12vin, 5.0V/20A out.*

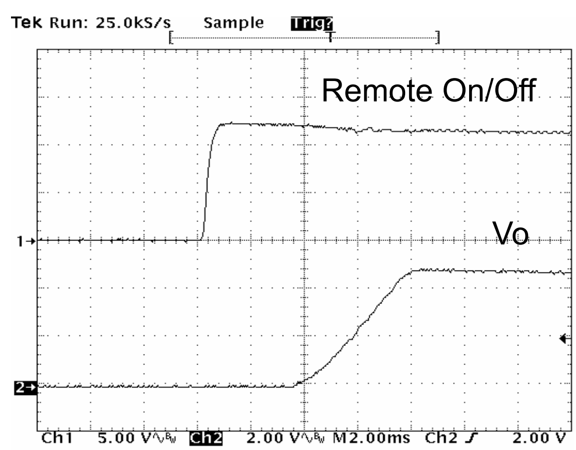


Figure 17: *Turn on Using Remote On/Off with external capacitors (Co= 5000 µF), 5.0V/20A out.*

ELECTRICAL CHARACTERISTICS CURVES

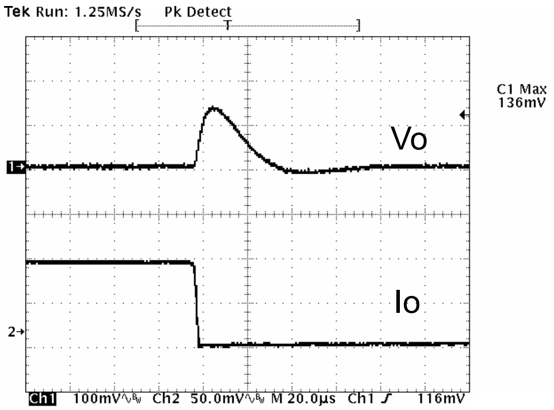


Figure 18: *Typical transient response to step load change at 5A/µS from 100% to 50% of Io, max at 12Vin, 0.75V out (Cout = 1uF+ 100uF ceramic, 470uF poscap).*

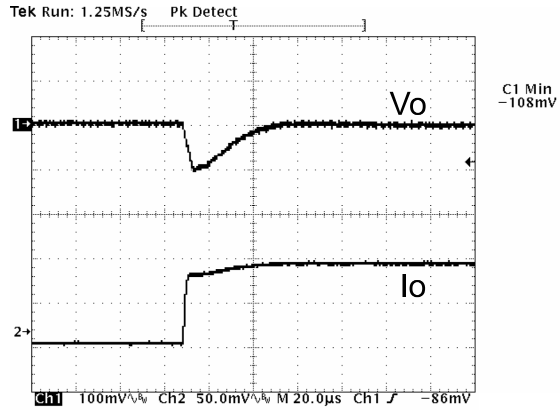


Figure 19: *Typical transient response to step load change at 5A/µS from 50% to 100% of Io, max at 12Vin, 0.75V out (Cout = 1uF+ 100uF ceramic, 470uF poscap).*

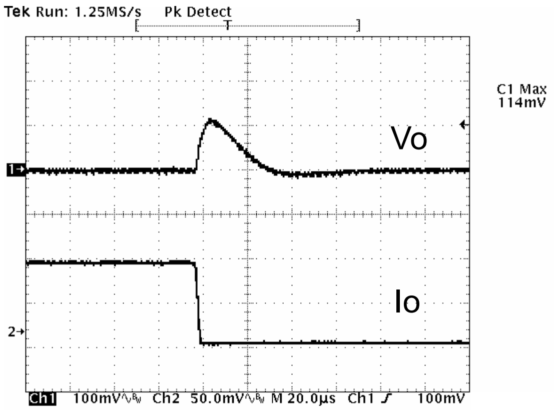


Figure 20: *Typical transient response to step load change at 5A/µS from 100% to 50% of Io, max at 12Vin, 1.2V out (Cout = 1uF+ 100uF ceramic, 470uF poscap).*

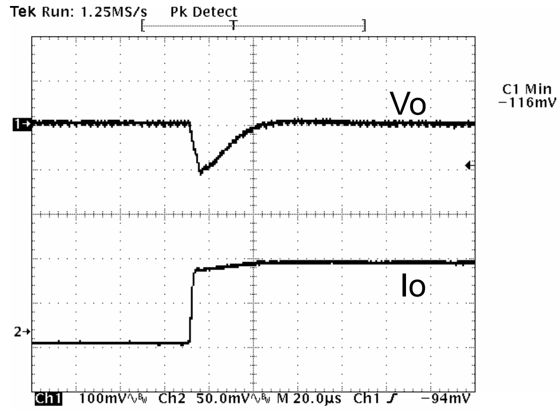


Figure 21: *Typical transient response to step load change at 5A/µS from 100% to 50% of Io, max at 12Vin, 1.2V out (Cout = 1uF+ 100uF ceramic, 470uF poscap).*

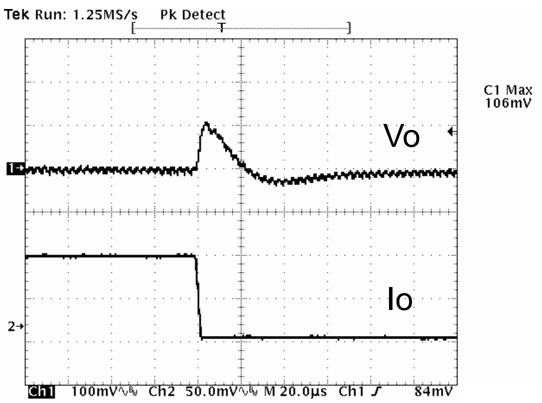


Figure 22: *Typical transient response to step load change at 5A/µS from 100% to 50% of Io, max at 12Vin, 2.5V out (Cout = 1uF+ 100uF ceramic, 470uF poscap).*

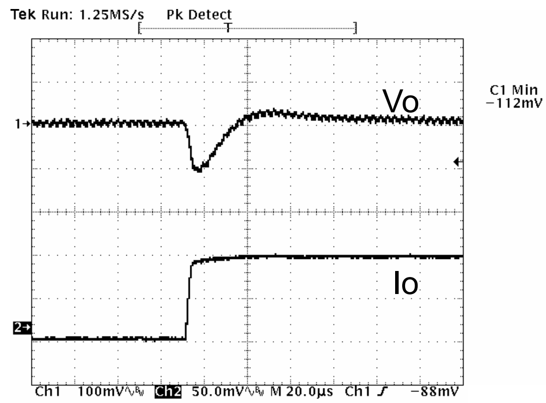


Figure 23: *Typical transient response to step load change at 5A/µS from 50% to 100% of Io, max at 12Vin, 2.5V out (Cout = 1uF+ 100uF ceramic, 470uF poscap).*

ELECTRICAL CHARACTERISTICS CURVES

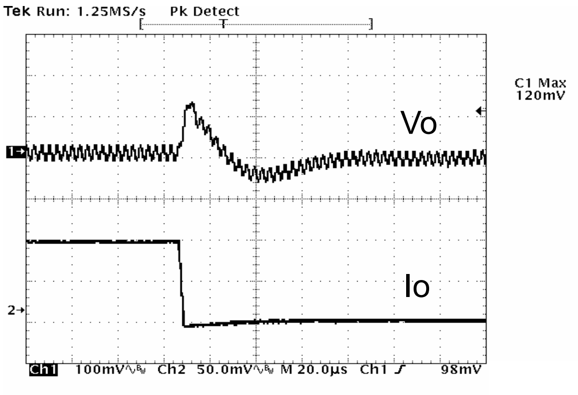


Figure 24: *Typical transient response to step load change at 5A/µS from 100% to 50% of Io, max at 12Vin, 5.0V out (Cout = 1uF+ 100uF ceramic, 470uF poscap).*

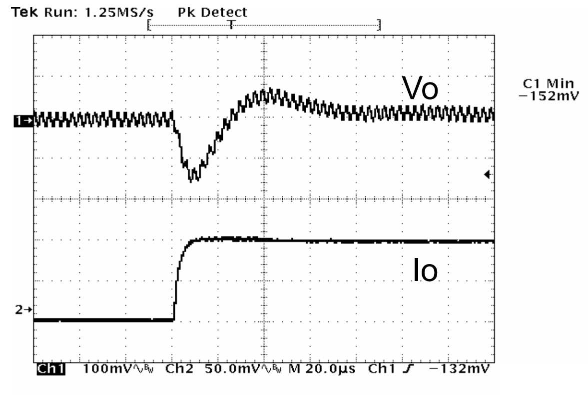


Figure 25: *Typical transient response to step load change at 5A/µS from 100% to 50% of Io, max at 12Vin, 5.0V out (Cout = 1uF+ 100uF ceramic, 470uF poscap).*

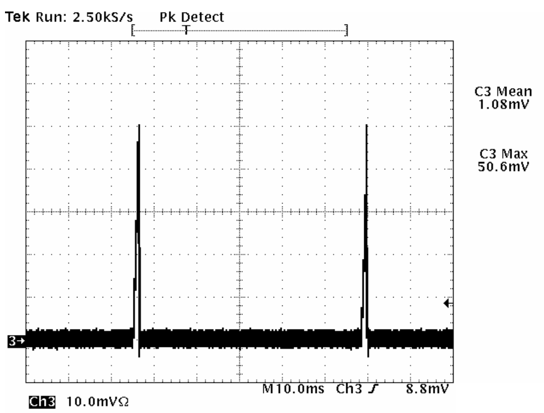


Figure 26: *Output short circuit current 12Vin, 0.75Vout* (10A/div).

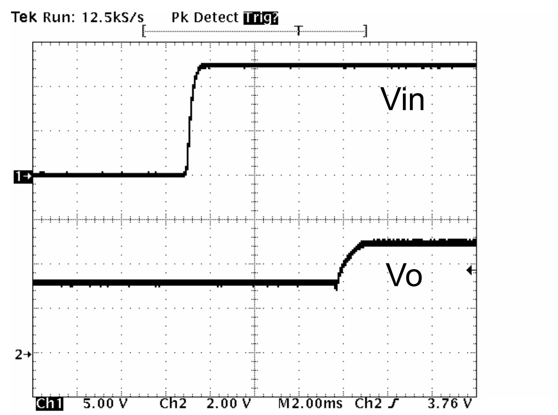
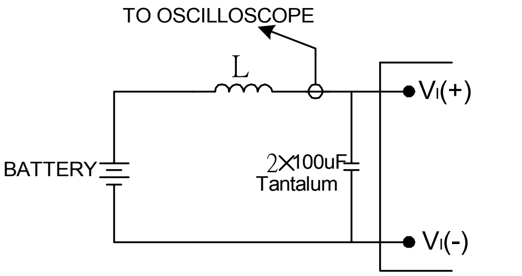


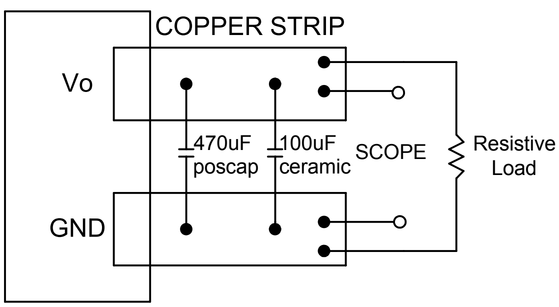
Figure 27: *Turn on with Prebias 12Vin, 5V/0A out, Vbias =3.3Vdc.*

TEST CONFIGURATIONS



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

***Figure 28:** Input reflected-ripple test setup*



Note: Use a 470μF poscap and 100μF ceramic. Scope measurement should be made using a BNC connector.

***Figure 29:** Peak-peak output noise and startup transient measurement test setup*

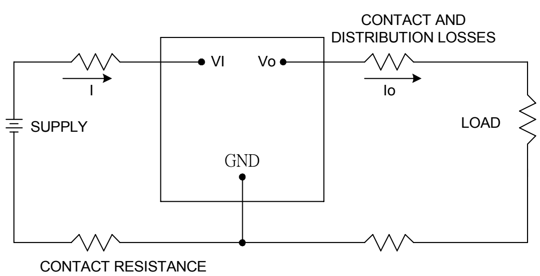


***Figure 30:** Output voltage and efficiency measurement test setup*

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. The models using 6x47uF low ESR tantalum capacitors (SANYO P/N:16TQC47M, 47uF/16V or equivalent) and 6x22 uF very low ESR ceramic capacitors (TDK P/N:C3225X7S1C226MT, 22uF/16V or equivalent) for example.

The input capacitance should be able to handle an AC ripple current of at least:

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

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 18A of fast-acting fuse in the ungrounded lead.

FEATURES DESCRIPTIONS

Remote On/Off

The DNL 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 DNL 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 31). 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 32) 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)

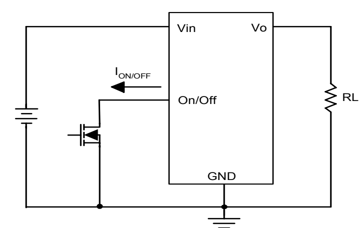


Figure 31: *Positive remote On/Off implementation*

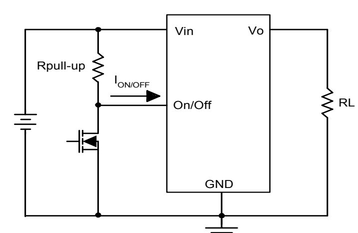


Figure 32: *Negative remote On/Off implementation*

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.

FEATURES DESCRIPTIONS (CON.)

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 DNL 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.

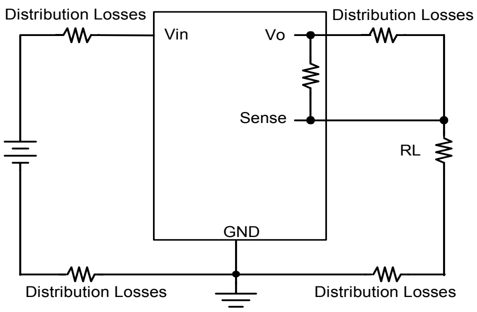


Figure 33: *Effective circuit configuration for remote sense operation*

Output Voltage Programming

The output voltage of the DNL can be programmed to any voltage between 0.75Vdc and 5.0Vdc by connecting one resistor (shown as Rtrim in Figure 34) 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:

$$Rtrim := \left(\frac{10500}{Vo - 0.7525} - 1000\right)\cdot\Omega$$

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

For example, to program the output voltage of the DNL module to 3.3Vdc, Rtrim is calculated as follows:

$$Rtrim := \left(\frac{10500}{2.5475} - 1000\right)\cdot\Omega$$

Rtrim = 3.122 kΩ

DNL can also be programmed by applying a voltage between the TRIM and GND pins (Figure 35). The following equation can be used to determine the value of Vtrim needed for a desired output voltage Vo:

$$Vtrim := 0.7 - [(Vo - 0.7525)\cdot 0.0667]$$

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

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

$$Vtrim := 0.7 - (2.5475\cdot 0.0667)$$

Vtrim = 0.530V

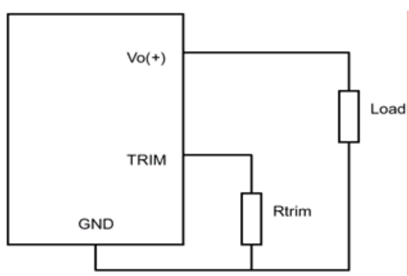


Figure 34: *Circuit configuration for programming output voltage using an external resistor*

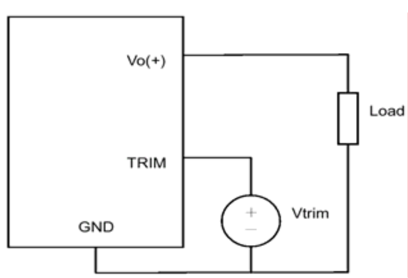


Figure 35: *Circuit Configuration for programming output voltage using external voltage source*

FEATURE DESCRIPTIONS (CON.)

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

Table 1

VO (V)	Rtrim (KΩ)
0.7525	Open
1.0	41.424
1.2	22.464
1.5	13.047
1.8	9.024
2.0	7.416
2.5	5.009
3.3	3.122
5.0	1.472

Table 2

VO (V)	Vtrim (V)
0.7525	Open
1.0	0.6835
1.2	0.670
1.5	0.650
1.8	0.630
2.0	0.6168
2.5	0.583
3.3	0.530
5.0	0.4167

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 ($V_{o.set} \times I_{o.max} \le P_{max}$).

Voltage Margining

Output voltage margining can be implemented in the DNL 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 36 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.

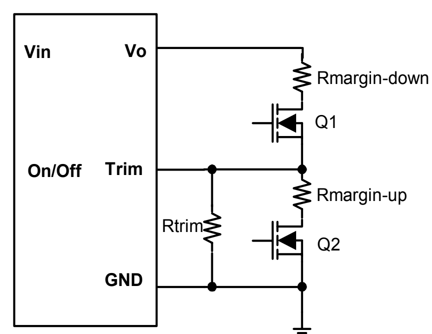


Figure 36: *Circuit configuration for output voltage margining*

FEATURE DESCRIPTIONS (CON.)

The output voltage tracking feature (Figure 37 to Figure 39) is achieved according to the different external connections. If the tracking feature is not used, the TRACK pin of the module can be left unconnected or tied to Vin.

For proper voltage tracking, input voltage of the tracking power module must be applied in advance, and the remote on/off pin has to be in turn-on status. (Negative logic: Tied to GND or unconnected. Positive logic: Tied to Vin or unconnected)

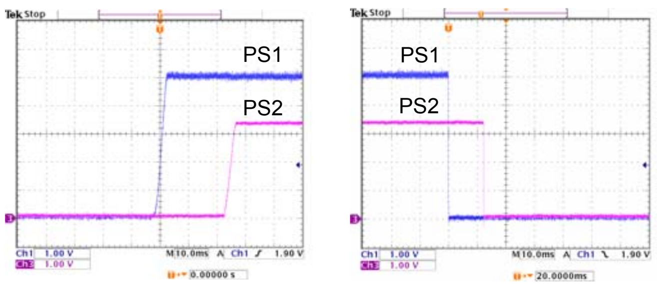


Figure 37: *Sequential start-up*

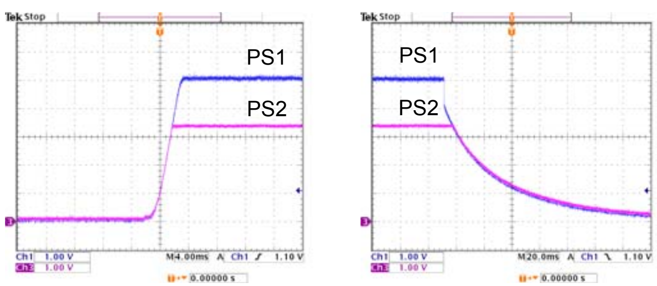


Figure 38: *Simultaneous*

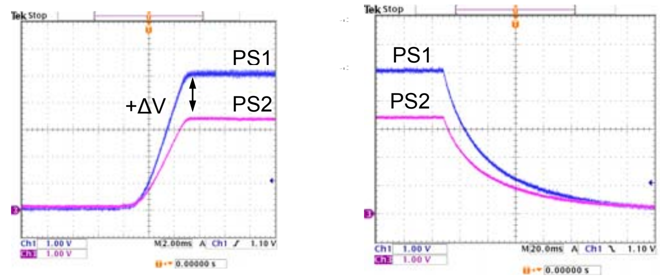
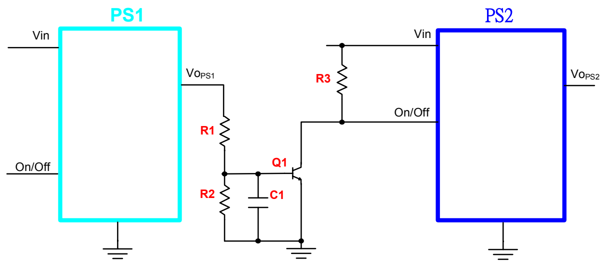


Figure 39: *Ratio-metric*

FEATURE DESCRIPTIONS (CON.)

Sequential Start-up

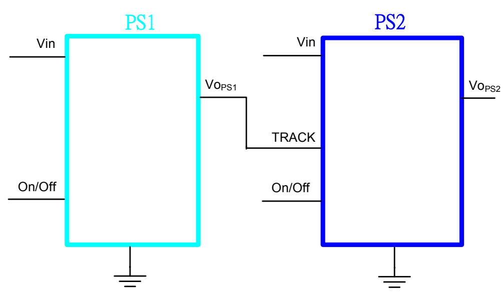
Sequential start-up (Figure 37) is implemented by placing an On/Off control circuit between Vo_{PS1} and the On/Off pin of PS2.



Simultaneous

Simultaneous tracking (Figure 38) is implemented by using the TRACK pin. The objective is to minimize the voltage difference between the power supply outputs during power up and down.

The simultaneous tracking can be accomplished by connecting Vo_{PS1} to the TRACK pin of PS2. Please note the voltage apply to TRACK pin needs to always higher than the Vo_{PS2} set point voltage.



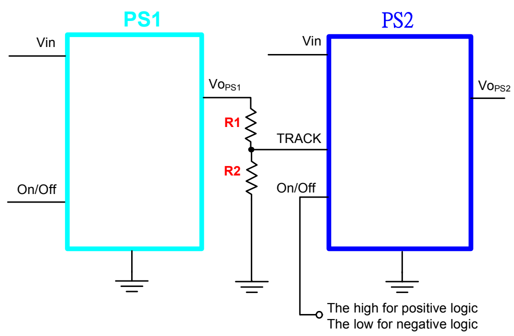
Ratio-Metric

Ratio–metric (Figure 39) is implemented by placing the voltage divider on the TRACK pin that comprises R1 and R2, to create a proportional voltage with Vo_{PS1} to the Track pin of PS2.

For Ratio-Metric applications that need the outputs of PS1 and PS2 reach the regulation set point at the same time

The following equation can be used to calculate the value of R1 and R2.
The suggested value of R2 is 10kΩ.

$$\frac{V_{o,PS2}}{V_{o,PS1}} = \frac{R_2}{R_1 + R_2}$$



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.

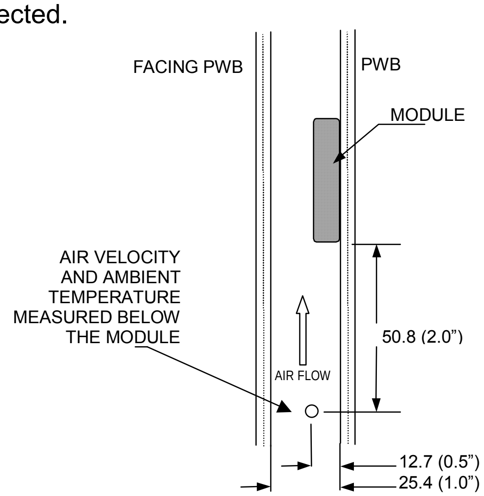
Thermal Testing Setup

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 40: *Wind tunnel test setup*

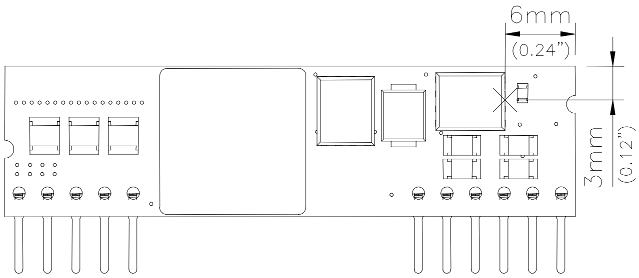


Figure 41: *Temperature measurement location*
** The allowed maximum hot spot temperature is defined at 120℃.*

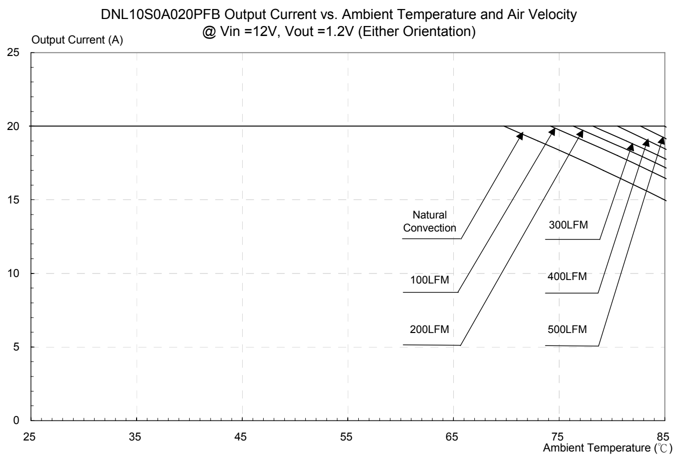


Figure42: *Output current vs. ambient temperature and air velocity @ Vin=12V, Vout=1.2V(Either Orientation)*

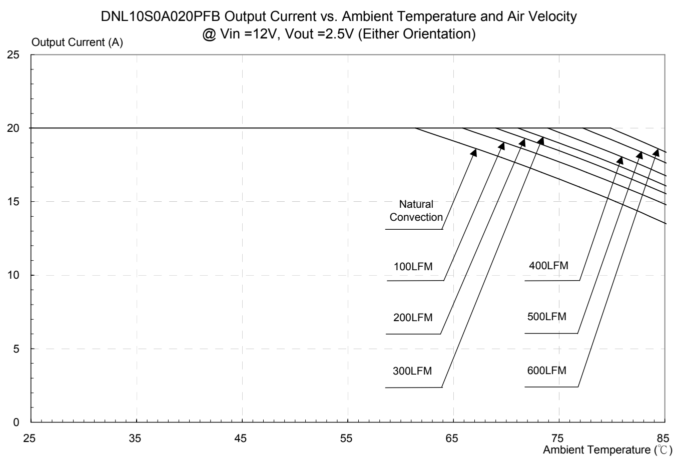


Figure 43: *Output current vs. ambient temperature and air velocity @ Vin=12V, Vout=2.5V(Either Orientation)*

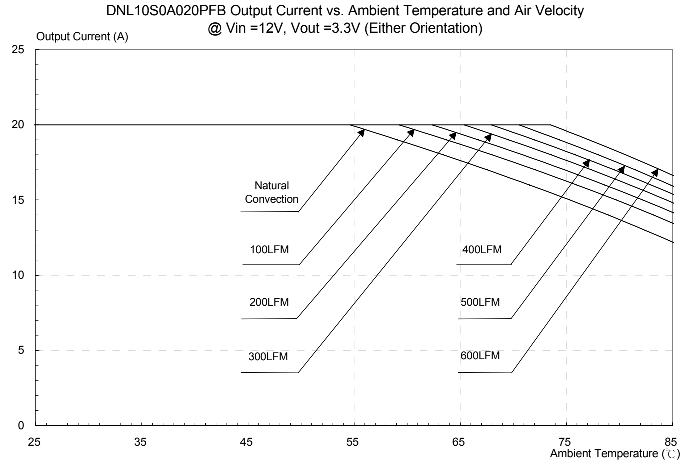


Figure 44: *Output current vs. ambient temperature and air velocity @ Vin=12V, Vout=3.3V(Either Orientation)*

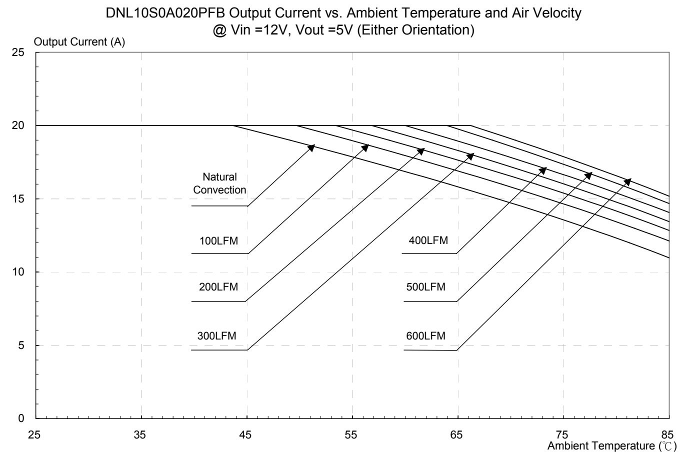
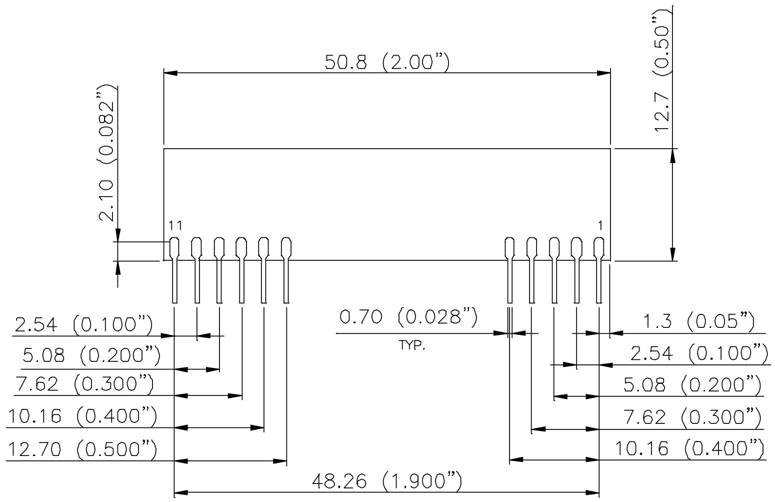


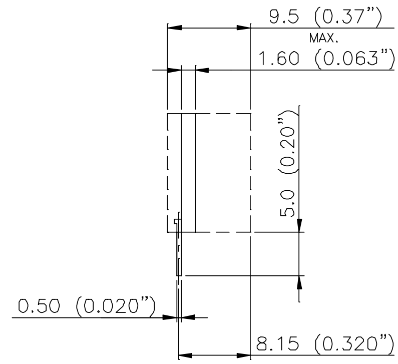
Figure 45: *Output current vs. ambient temperature and air velocity @ Vin=12V, Vout=5.0V(Either Orientation)*

MECHANICAL DRAWING

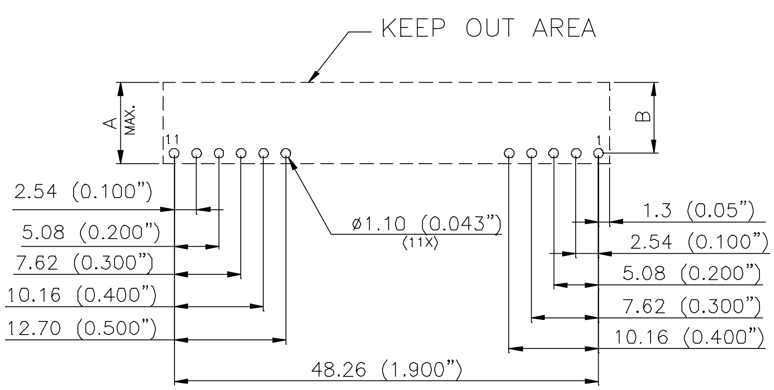
SIP PACKAGE



BACK VIEW



SIDE VIEW



PIN#	Function
1	Vo
2	Vo
3	Vo SENSE
4	Vo
5	GND
6	GND
7	Vi
8	Vi
9	TRACK
10	TRIM
11	ON/OFF

A	B
9.5 (0.37")	8.15 (0.320")

RECOMMENDED P.W.B PAD 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

DNL	10	S	0A0	R	20	P	F	D
Product Series	**Input Voltage**	**Numbers of Outputs**	**Output Voltage**	**Package Type**	**Output Current**	**On/Off logic**		**Option Code**
DNL - 16/20A DNM -10A DNS - 6A	10 - 8.3V ~14V	S - Single	0A0 - Programmable	R - SIP S - SMD	20 -20A	P - Positive N - Negative	F - RoHS 6/6 (Lead Free)	B - No Tracking Pin D - Standard Functions

MODEL LIST

Model Name	Packaging	Input Voltage	Output Voltage	Output Current	On/Off logic	Efficiency 12Vin @ 100% load
DNL10S0A0R20PFD	SIP	8.3V ~ 14V	0.75V ~ 5.0V	20A	Positive	93.5% (5.0V)
DNL10S0A0R20PFB	SIP	8.3V ~ 14V	0.75V ~ 5.0V	20A	Positive	93.5% (5.0V)

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WARRANTY

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