TABLE OF CONTENTS

NW25S

25 Watts Output Power

SINGLE OUTPUT

How to Order:

NW 25 S I / 5 - A - F

- Series: NW
- Total Output Power: 25
- Single Output: S
- Unscreened (I) or Screened (M): I / M
- Output Voltage: Max.current as stated in selection chart: 5
- Options: A - F
  - STD - pins out top of unit
  - Options:
    - A - Terminal Block
    - I - M2.5 inserts
    - F - EMI Filter (internal)

FEATURES

- **Over Temperature Protection**
- **Remote Turn On (TTL)**
- **Output Overvoltage Protection**
- **Output Overcurrent Protection**
- **100% Environmental Screening (M Version)**
- **Remote Sense**

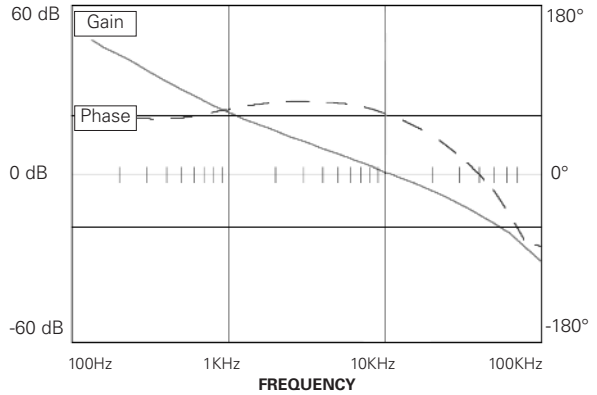
SELECTION CHART

Nominal Output Voltage	Output Current (Amps)	Model Number (Unscreened)	Model Number (Screened)
2	5.0	NW25SI/2	NW5SM/2
3.3	5.0	NW25SI/3.3	NW25SM/3.3
5	5.0	NW25SI/5	NW25SM/5
5.2	4.8	NW25SI/5.2	NW25SM/5.2
9	2.8	NW25SI/9	NW25SM/9
12	2.1	NW25S/12	NW25SM/12
15	1.66	NW25SI/15	NW25SM/15
24	1.1	NW25SI/24	NW25SM/24
28	0.9	NW25SI/28	NW25SM/28

INPUT CHARACTERISTICS

	Per Channel			
	Min.	Typ.	Max.	Units
Input Voltage (47-440 Hz)	90	110	130	Vac
	120	150	184	Vdc
Brown Out (75% of Full Load) [fig. I]*			80	Vac
No Load Power Dissipation		1.0	1.5	Watt
Inrush Current [fig. VI]*		15		A
Logic Disable Current (Sink)		5	6	mA
Logic Disable Power In		1.0	1.5	Watt
Efficiency (FL) [fig. II, III]*	75	80-86		%
3.3 Vdc Output (FL)	70	74		%
2 Vdc Output (FL)	60	65		%
Power Factor (110 Vac, 60Hz)				
Half Load		0.55		
Full Load		0.59		
EMI: Units conform to Mil-Std-461D (on input pins) with optional internal filter (-F)				
Input Transient: Units can withstand 180Vac transients up to 0.1 second				

STABILITY



OUTPUT CHARACTERISTICS

	Per Channel			
	Min.	Typ.	Max.	Units
Set Point Accuracy			1 †	% V_{out}
Load Regulation		0.1	0.2	% V_{out}
Line Regulation		0.1	0.2	% V_{out}
Ripple P-P (10 MHz) [fig. IV]*		50	150	mV
Remote Sense Compensation		0.5		Vdc
Overvoltage Protection		125		% V_{out}
Transient Response (V_{out} 1%) Time/Overshoot				
20-80% Load		500/300		µS/mV
Low Line - High Line		500/300		µS/mV
50-100% Load [fig.V]*		500/300		µS/mV
Temperature Drift		0.01	0.02	%/°C
Long Term Drift		0.01		%/1KHrs
Current Limit		130		% I_{out}
Short Circuit Current		50		% I_{out}
Turn On Time [fig. IX]*		200		mS
Logic Turn On Time [fig. VII]*		3		mS

† 1% or 50mV (whichever is greater)
* figures on page 6

All specifications are typical @+25°C with nominal input voltage under full output load conditions, unless otherwise noted. Specifications subject to change without notice.

Martek Power Abbott, Inc. 2727 S. La Cienega Blvd., Los Angeles, CA 90034 U.S.A. Tel: 310.202.8820 Fax: 310.836.4926
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TEMPERATURE CHARACTERISTICS

	Min.	Typ.	Max.	Units
Operating	-40		+90	°C
Storage - Ambient	-55		+115	°C
Over Temperature Shutdown		+95		°C
Thermal Resistance Case- Ambient		5		°C/W

M- GRADE - ENVIRONMENTAL SCREENING

Stabilization Bake:	+115°C for 24 hours similar to Mil-Std-883, M1108, Condition B
Temperature Cycling:	10 cycles at -55°C to +115°C (transition period 5°C /min) similar to Mil-Std-883, M1010, Condition B
Burn in:	160 hours @ 75°C minimum
Final Testing	

I- GRADE - ENVIRONMENTAL SCREENING

Burn in:	16 hours @ 75°C minimum
Final Testing	

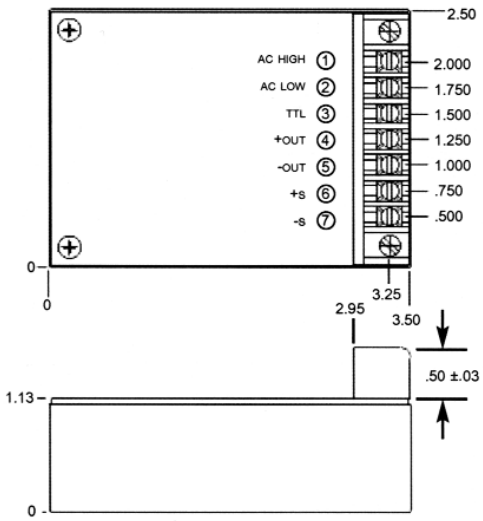
ISOLATION CHARACTERISTICS

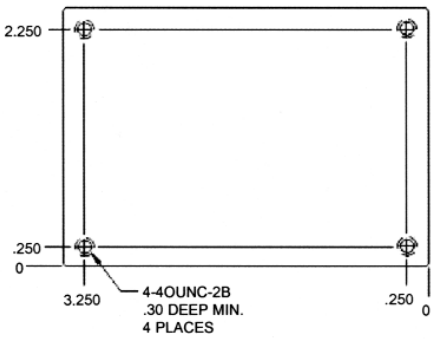
	Min.	Units
Isolation:		
Input to Output	500	Vdc
Output to Base	500	Vdc
Input to Base	500	Vdc
Insulation Resistance (@50 Vdc)	50	MOhm

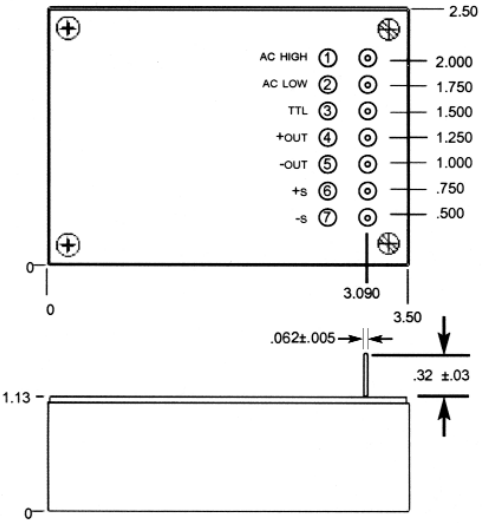
MECHANICAL CHARACTERISTICS

Weight	14.4 408.2	oz. grams
Size	3.5 x 2.5 x 1.13 88.9 x 63.5 x 28.7	inch mm
Volume	9.89 162	$inch^3$ cm^3
Material	24GA CRS	
Finish	Nickel Plating	
Mounting	4-40 Inserts	

CASE DRAWINGS







(-A OPTIONAL TERMINAL BLOCK)

Wire Guage: 18 AWG Max

(STANDARD PINS)

Tolerances: inches - x.xx = ±0.03
x.xxx = ±0.015

All specifications are typical @+25°C with nominal input voltage under full output load conditions, unless otherwise noted. Specifications subject to change without notice.

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NW50D

50 Watts Output Power

DUAL OUTPUT

How to Order:

NW 50 D M / 5 / 12 - A - F

- Series
- Total Output Power
- Dual Output
- Unscreened (I) or Screened (M)
- Output Voltages: Max.current as stated in selection chart
- Options:
  - STD - pins out top of unit
  - Options:
    - A - Terminal Block
    - I - M2.5 inserts
    - F - EMI Filter (internal)

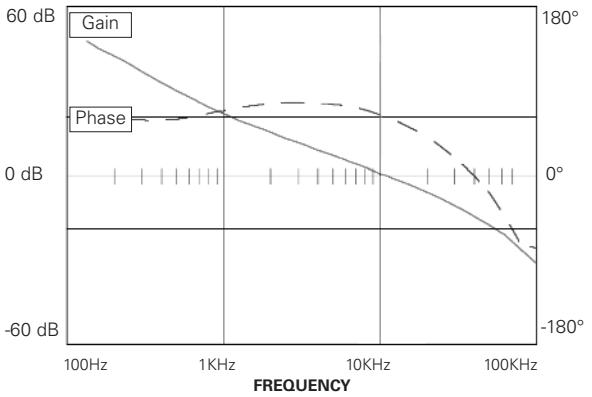
INPUT CHARACTERISTICS

	Per Channel			
	Min.	Typ.	Max.	Units
Input Voltage (47-440 Hz)	90	110	130	Vac
	120	150	184	Vdc
Brown Out (75% of Full Load) [fig. I]*			80	Vac
No Load Power Dissipation		1.0	1.5	Watt
Inrush Current [fig. VI]*		15		A
Logic Disable Current (Sink)		5	6	mA
Logic Disable Power In		1.0	1.5	Watt
Efficiency (FL) [fig. II, III]*	75	80-86		%
3.3 Vdc Output (FL)	70	74		%
2 Vdc Output (FL)	60	65		%
Power Factor (110 Vac, 60Hz)				
Half Load		0.55		
Full Load		0.59		

EMI: Units conform to Mil-Std-461D (on input pins) with optional internal filter (-F)

Input Transient: Units can withstand 180Vac transients up to 0.1 second

STABILITY



FEATURES

- **Over Temperature Protection**
- **Remote Turn On (TTL)**
- **Output Overvoltage Protection**
- **Output Overcurrent Protection**
- **100% Environmental Screening (M Version)**

Model Numbering Example:
An environmentally screened, 50 watts, dual output, 5 Vdc and 15 Vdc, the model number would be NW50MI/5/15. A non-environmentally screened dual output, 12 Vdc and 15 Vdc, would be model number NW50DI/12/15. The first output voltage in the model number is located on channel 1, and the second output voltage in the model number is located on channel 2 (see case drawing).

SELECTION CHART

Nominal Output Voltage	Dual Per Channel Current (Amps)
2	5.0
3.3	5.0
5	5.0
5.2	4.8
9	2.8
12	2.1
15	1.66
24	1.1
28	0.9

NOTE : Any output voltage can be located in either Channel 1 or Channel 2

OUTPUT CHARACTERISTICS

	Per Channel			
	Min.	Typ.	Max.	Units
Set Point Accuracy			1 †	% V_{out}
Load Regulation		0.1	0.2	% V_{out}
Line Regulation		0.1	0.2	% V_{out}
Ripple P-P (10 MHz) [fig. IV]*		50	100**	mV
Overvoltage Protection		125		% V_{out}
Transient Response (V_{out} 1%) Time/Overshoot				
20-80% Load		500/300		µS/mV
Low Line - High Line		500/300		µS/mV
50-100% Load [fig. V]*		500/300		µS/mV
Temperature Drift		0.01	0.02	%/°C
Long Term Drift		0.01		%/1KHrs
Current Limit		130		% I_{out}
Short Circuit Current		50		% I_{out}
Turn On Time [fig. IX]*		200		mS
Logic Turn On Time [fig. VII]*		3		mS

† 1% or 50mV (whichever is greater)
* figures on page 6
** or 1% V_{out} (whichever is greater)

All specifications are typical @+25°C with nominal input voltage under full output load conditions, unless otherwise noted. Specifications subject to change without notice.

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TEMPERATURE CHARACTERISTICS

	Min.	Typ.	Max.	Units
Operating	-40		+90	°C
Storage - Ambient	-55		+115	°C
Over Temperature Shutdown		+95		°C
Thermal Resistance Case- Ambient		5		°C/W

M- GRADE - ENVIRONMENTAL SCREENING

Stabilization Bake:	+115°C for 24 hours similar to Mil-Std-883, M1108, Condition B
Temperature Cycling:	10 cycles at -55°C to +115°C (transition period 5°C /min) similar to Mil-Std-883, M1010, Condition B
Burn in:	160 hours @ 75°C minimum
Final Testing	

I- GRADE - ENVIRONMENTAL SCREENING

Burn in:	16 hours @ 75°C minimum
Final Testing	

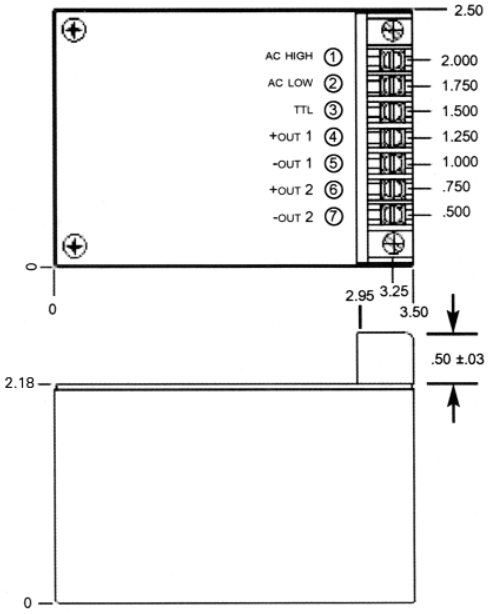
ISOLATION CHARACTERISTICS

	Min.	Units
Isolation:		
Input to Output	500	Vdc
Output to Base	500	Vdc
Input to Base	500	Vdc
Insulation Resistance (@50 Vdc)	50	MOhm

MECHANICAL CHARACTERISTICS

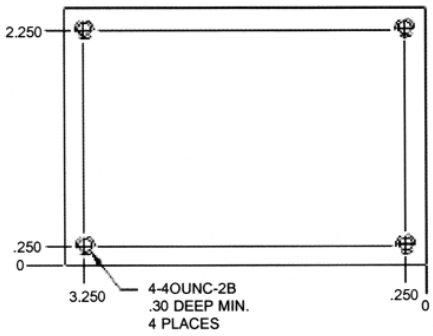
Weight	28.8 816.4	oz. grams
Size	3.5 x 2.5 x 2.18 88.9 x 63.5 x 55.4	inch mm
Volume	19.08 312.7	$inch^3$ cm^3
Material	24GA CRS	
Finish	Nickel Plating	
Mounting	4-40 Inserts	

CASE DRAWINGS

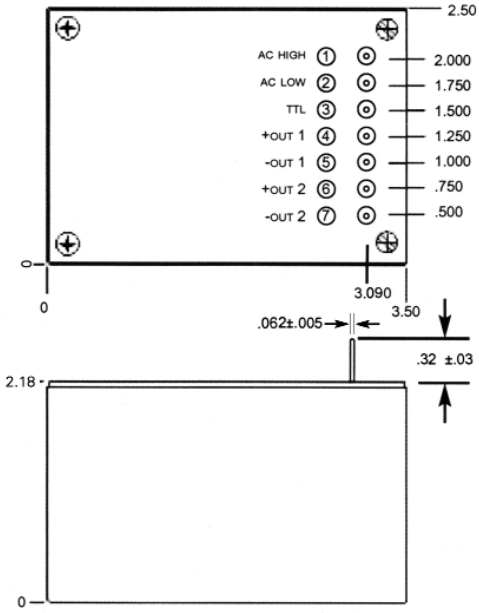


(-A OPTIONAL TERMINAL BLOCK)

Wire Guage: 18 AWG Max



(STANDARD INSERTS)



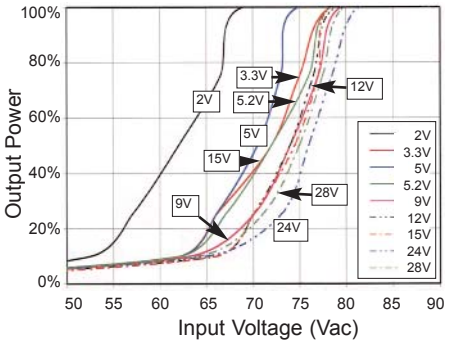
(STANDARD PINS)

Tolerances: inches - x.xx = ±0.03
x.xxx = ±0.015

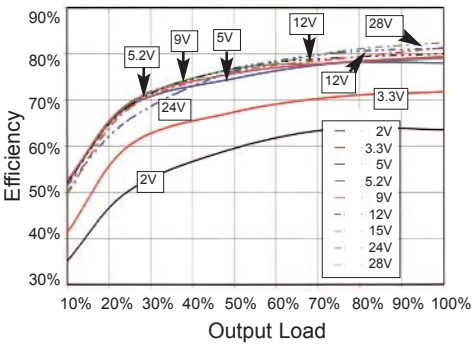
All specifications are typical @+25°C with nominal input voltage under full output load conditions, unless otherwise noted. Specifications subject to change without notice.

Performance Characteristics

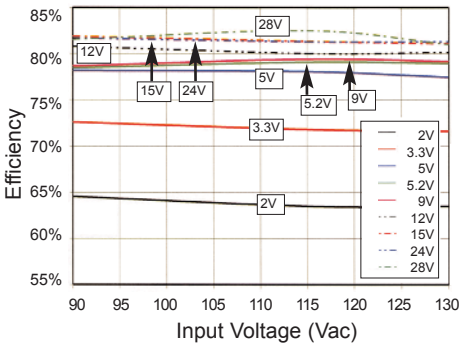
I. Input Voltage vs. Output Power



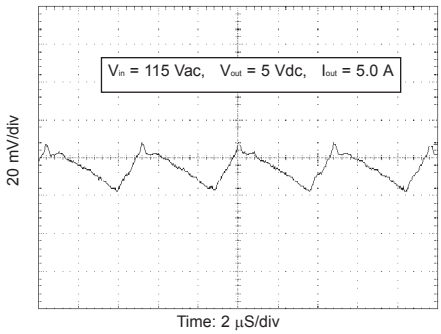
II. Efficiency vs. Output Power



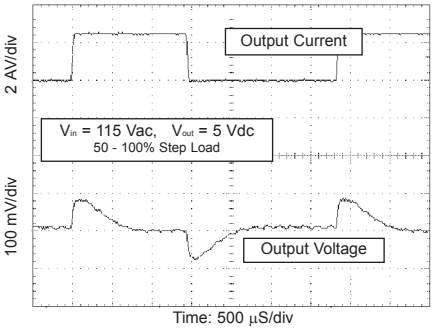
III. Efficiency vs. Input Voltage



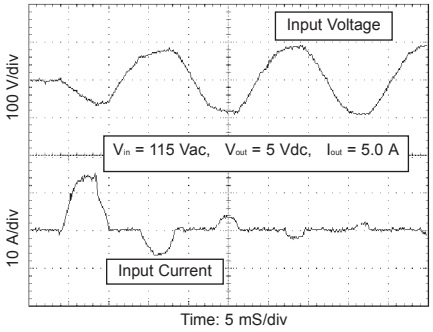
IV. Output Voltage Ripple



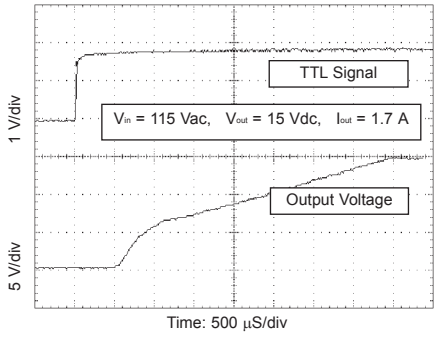
V. Load Transient Response



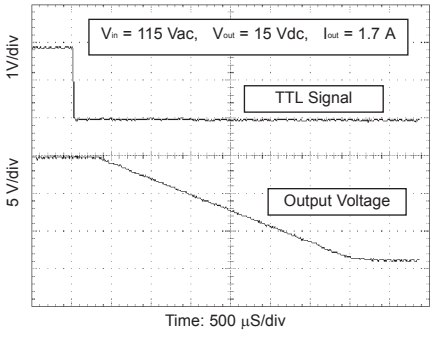
VI. Input Inrush Current



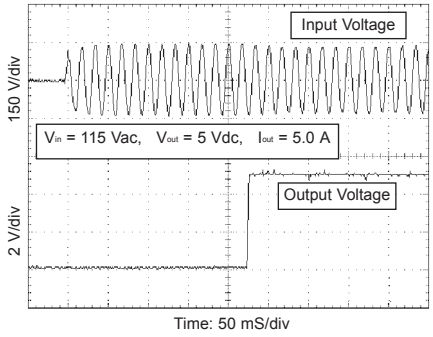
VII. TTL Turn-On



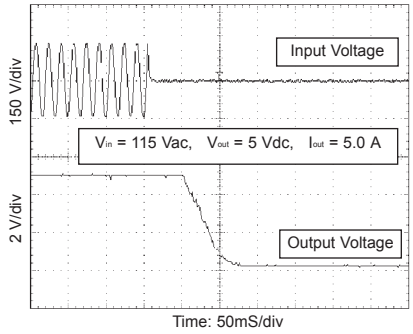
VIII. TTL Turn-Off



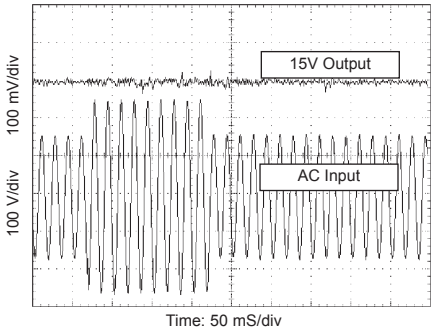
IX. AC Turn-On



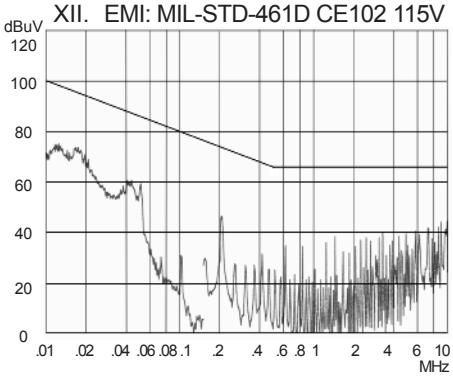
X. AC Turn-Off



XI. Input Transient Response



XII. EMI: MIL-STD-461D CE102 115V



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GUIDE TO OPERATION

I. ELECTRICAL DESCRIPTION

The NW Series of power converters uses a double-ended forward converter topology. This topology dramatically reduces switching losses to yield higher converter efficiencies and lower output ripple. Advanced current mode control is utilized enabling fast transient response time. The switching frequency of the NW series is factory set greater than 180 kHz but less than 200 kHz. Sufficient capacitance on the input and output, internal to the unit, allows for simple use and operation with no external components in most applications. An internal EMI filter is available via Option "F".

II. MECHANICAL DESCRIPTION

General Description

The NW series converters are encased in a 6 sided steel can to facilitate heat transfer. The NW series is available in two pin-out configurations; Terminal Block (Option A) or pins out the top (Standard). The pins are non-rigid and may be formed to suit specific mounting configurations. Care should be taken not to excessively bend or over stress the pins to avoid breakage.

The high efficiency of the NW reduces heat dissipation and minimizes heat sinking requirements i.e., maximum dissipation of the 25 watt converter operation at full load will be between 4 and 9 watts. Though this reduces heat sinking requirements, the baseplate temperature must be maintained below +90°C or thermal shutdown may occur.

Installation and Mounting

Each NW unit has a label on it that will clearly identify pin functions and electrical ratings. Descriptions of these functions can be found in the "Guide to Operation" and the "Application Notes" sections. Before electrically wiring the converter we recommend carefully reviewing the application notes section entitled "General Application Notes" and "Wire Gage & Distance to Load".

III. MILITARY SPECIFICATIONS

The NW Series is environmentally sealed and meets the following military specifications.

Specification	*Condition*	*Method*	*Procedure*	*Test Condition*
MIL-STD-704A	Input Transient			Transients up to 180 Vac for 0.1 second
MIL-STD-810E	Vibration	514.4	1	Up to 30gs, each axis for 1 hour
MIL-STD-810E	Humidity	507.3	1	95% humidity, non-condensing for 10 days
MIL-STD-810E	Temp/Altitude	520.1	3	40 hours from -55°C to +71°C
MIL-STD-810E	Acceleration	513.4	3	14gs each axis
MIL-STD-810E	Temperature Shock	503.3		-40°C to +90°C (non-operating, one hour each cycle)
MIL-STD-901C	High Impact Shock			5 foot hammer drop

IV. PRODUCT FEATURE

Remote Output Voltage Sensing

Output voltage sensing is provided for either local (at the unit) or remote (at the load) sensing. The sense feature can automatically compensate for up to a 0.5V drop in the leads to the load. The sense pins must be connected

(either local or remote) for operation or PERMANENT DAMAGE MAY OCCUR. If remote sensing is not desired it is required to tie the sense pins locally, i.e., -sense to -output and +sense to +output. The NW50D (Dual Output) does not contain remote sensing.

TTL (Remote on/off)

The TTL feature is used to command the NW series on and off and is referenced to the output return. When the TTL pin is left unconnected or, if a voltage between 2.4V and 5.0V is applied to the pin, the converter will remain on. When the TTL pin is pulled down below 0.8V the unit will turn off. In dual configurations, TTL is referenced to channel 1 output ground.

Over Temperature Protection

An integral electronic over temperature shut down circuit is provided to protect the NW series from accidental over heating. If the temperature (measured at the baseplate) of the converter exceeds 95°C, the unit will automatically shut down. Once the temperature (measured at the baseplate) is reduced to 85% of the rated high operating temperature, power will be automatically restored.

Overload/ Short Circuit Protection

The output of the NW Series is protected from an accidental overload or short circuit condition of any duration. When the output load exceeds the full load capability of the supply (typically 130% of the maximum rated output current) the converter switches into a "Burp-Mode" (this is where the converter is sensing the overload and is continuously turning on and off in a controlled fashion). When the overload/short circuit is removed the converter automatically returns to its normal mode of operation.

Over Voltage Protection

The NW series provides an internal "Latching" overvoltage protection circuit. Should an overvoltage condition occur the converter will shut off. The input must be recycled to restore output.

V. RELIABILITY

Reliability Calculation

The Mean Time Between Failure (MTBF) per Mil-HBDK-217F Notice 2 calculated for the NW50SI (Unscreened Version) under the operating conditions of 50°C baseplate, maximum rated output power is 675,000 hours for a ground benign environment. The MTBF for the NW50SM (M version) is 1,340,000 hours under similar conditions.

Standard M Grade Module Screening

Each M Grade NW module under goes environmental screening based upon the parameters outlined in Mil-Std-883 and NAVMAT P4855-1. The screening and process steps consist of the following:

1- Stabilization Bake; +115°C for 24 hours similar to Mil-Std-883, M1108 Condition B
2- Voltage Isolation and Parametric Testing at 25°C
3- Module encapsulation and sealing
4- Temperature Cycling (non-operational); 10 cycles minimum, at -55°C to +115°C, 34 minute transition with a 1 hour dwell at each temperature extreme. Procedure reference Mil-Std-883, M1010, condition B and NAVMAT P4855-1.
5- Voltage Isolation and Parametric Testing at 25°C
6- Long Term Operational Burn In; 160 hours of powered operation under load. Baseplate temperature is maintained at 75°C minimum.
7- Voltage Isolation and Parametric Testing at 25°C
8- Visual Inspection

Additional testing is available including parametric testing at temperature or extended burn in time. Consult factory for more information. Additional testing or customer specific testing will require additional charges.

General Application Notes

The NW family of power converters were designed as industrial grade stand alone AC-DC converters which can also be used as components in complex power systems. The NW Series of power converters uses a double-ended forward converter topology. This topology dramatically reduces switching losses to yield higher converter efficiencies and lower output ripple. Advanced current mode control is utilized enabling fast transient response time. The switching frequency of the NW series is fixed at approximately 200 KHz. Sufficient capacitance on the input and output, internal to the unit, allows for simple use and operation with no external components in most applications. Optional internal input EMI filter is available (Option "F").

The NW units are supplied in a six-sided metal case to minimize radiated noise. The NW is available in two pin-out configurations; screw terminals (Option A) and pins out the top (Standand). The high efficiency of the NW reduces heat dissipation and minimizes heat sinking requirements(i.e., maximum dissipation of the 50-watt converter will be between 8 and 18 watts.) A number of protection features, as well as electrical and thermal derating of internal components allows for high reliability throughout the entire operating range. The operating range is -40°C to +90°C.

The most basic use of the power converter is shown in Figure 1. An input fuse is always recommended to protect both the source and the power supply in the event of failures. Bus fuse type MDX or equivalent slow-blow is recommended with a current rating approximately 200% of the full load input current to the converter. Having a slow-blow type fuse will allow for the converter's inrush charge at turn-on.

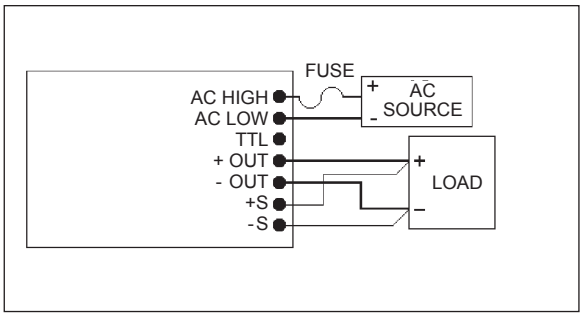

Figure 1. Basic converter hook-up (Remote Sense)

The sense pins of the converter (on the 25W single only) must be connected to their corresponding output pins at the load (Figure 1). Inherently, power converters will have some internal energy loss, which is dissipated in the form of heat through the mounting surface. This surface must be cooled to maintain a temperature below the maximum operating temperature.

The NW25 family of power converters comes with Remote Sense and TTL as standard features.

The NW50 Dual output family of power converters has the second output in place of the sense pins. Remote sense is not available and the TTL is referenced to the channel one output ground.

Wire Gage & Distance to Load

If the resistance of the wire, printed circuit board runs, or connectors used to connect a converter to system components is too high, excessive voltage drop will result between the converter and system components, degrading overall system performance.

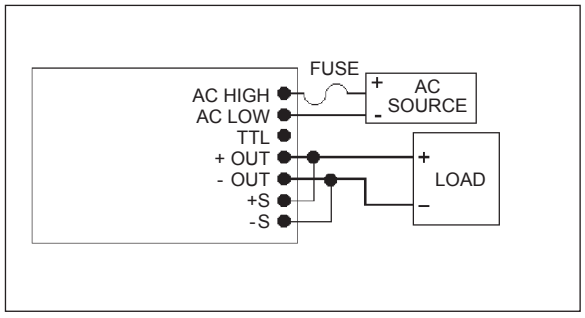

Figure 2. Converter Hook-up Losses

For example, if the DC/DC converter in Figure 2 is a 25W unit (5 VDC @ 5 Amps) with output load regulation specified at 0.2%; the connection as shown will degrade load regulation by a factor of 5. In this example, the 4 feet of #14 AWG wire used to connect the converter output to the load, has a total line resistance of 10 mΩ (ignoring any contact resistance). For a 25W, 5VDC output converter, the drop across the wire will be 50 mV (5 A X 0.010Ω) or 1% of the output. Thus, the converter was selected for 0.2% regulation, but the power system layout achieves only 1.2%.

This can be corrected by decreasing the distance between the converter output and load. If that is not possible, using larger diameter wire (see Table 1), or

#AWG	Resistance mW/Foot	#AWG	Resistance mΩ/Foot
9	0.792	21	12.77
10	0.998	22	16.20
11	1.261	23	20.30
12	1.558	24	25.67
13	2.001	25	32.37
14	2.524	26	41.02
15	3.181	27	51.44
16	4.020	28	65.31
17	5.054	29	81.21
18	6.386	30	103.7
19	8.046	31	130.9
20	10.13	32	162.0

Table 1. Wire Table Resistance

Note: High IR drops between the converter and load may cause converter parameters such as output voltage accuracy, trim range, etc. to appear to be out of specification. High IR drops on input lines may cause start up problems (voltage at the input pins below the input range of the converter).

PCB runs that have a larger cross sectional area and shorter length will also reduce conductor resistance. The use of the converter's remote sense capability is the ideal means of hook-up. (Figure 1)

Obviously, any connections made to the power distribution bus may present a problem. Poor connections (such as microcracking around solder joints) can cause serious problems such as arcing. Contact resistance must be minimized. Proper workmanship standards must be followed to insure reliable solder joints for board mount converters.

Terminal strips, spade lugs and edge connectors must be free of any corrosion, dust or dirt. If parallel lines or connections are available for routing converter output currents, they should be utilized.

Ripple & Noise

Output ripple and noise (sometimes referred to as PARD or "Periodic and Random Deviations") can be defined as unwanted variations in the output voltage of a power supply. In switching power supplies this output noise is seen as a series of pulses with a high frequency content and is therefore measured as a peak value (i.e., specified as "peak-to-peak").

Martek Power Abbott, Inc. power supplies are specified and tested in our factory with a 10 MHz bandwidth oscilloscope. Measurements taken by a scope set at higher frequencies (i.e., 300 MHz) may produce significantly different results due to noise coupling on to the probe from sources other than the power supply.

Noise that is common to all output leads of a power converter with respect to the chassis is referred to as common mode noise. Noise that is apparent on one output lead with respect to corresponding output lead is referred to differential mode noise. Common mode noise is produced by the switching action of the converter. Martek Power Abbott, Inc. typically minimizes the level of output common mode noise by incorporating line to chassis ground capacitors (on input and output leads) into the power converters. In most cases this is sufficient to minimize the level of common mode noise, however if further attenuation is required additional line to chassis ground capacitance may be added by the customer at the system level. Martek Power Abbott, Inc. noise specifications (output ripple specifications) all reference the level of differential mode noise at a given bandwidth, not the level of common mode noise. The measurement of differential mode noise is detailed in the following paragraphs.

Measurement Techniques

The length of all measurements leads (especially the ground leads) should be minimized and the sense pins should be tied to their respective outputs (+Sense to +V out). We recommend measurement as close to the supply as possible. This can be accomplished by connecting a short bus wire (generally 0.5 inches or less, making a loop at the end to place in the probe ground ring) to the negative side of the probe, then place the tip of the probe on the +output and ground ring (or ground band) on the -output for a true ripple measurement. This is displayed in Figure 3.

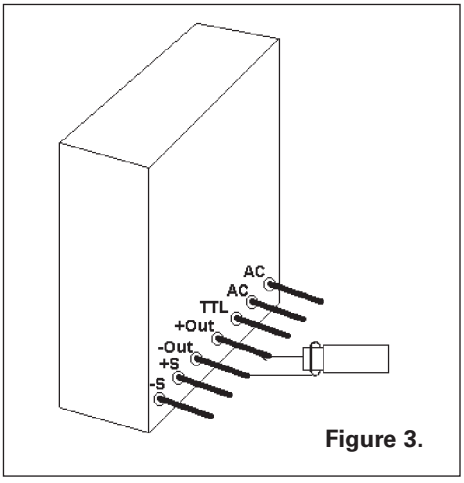

Figure 3.

Utilizing the probe ground ring (as opposed to a ground wire) will minimize the chance of noise coupling from sources other than the power supply.

Ripple Reduction Techniques

In applications where the output ripple of the converter is higher than desired, various techniques can be employed to reduce output ripple and noise (PARD). One method is to add additional capacitance in parallel with the output leads of the converter (low ESR type tantalums or ceramics are recommended). This should substantially reduce PARD.

Remote Sense

Remote sense pins, +S and -S have been provided as a standard feature on NW Series converters for applications where precise load regulation is required at a distance from where the converter is physically located (See Figure 1). If remote sensing is NOT required, these pins MUST be tied to their respective output pins (+S to +OUT and -S to -OUT), otherwise, severe damage may occur to the power supply or load. If one or more of these sense pins are not connected to their respective output pins, the output(s) of the unit will not regulate to within specification and may cause a high output voltage condition.

- DO NOT connect sense pins to any pin other than their respective output pins or permanent damage will occur.
- DO NOT connect sense pins to any load other than the same load the output pins are connected to or permanent damage may occur.

The internal remote sense circuit is designed to compensate for a maximum of 0.5V difference (0.25V in each output lead) in voltage between the load and the power converter. Longer output leads or traces are required to be of sufficient gauge or width to maintain the voltage drop across them of 0.5V maximum at rated load current.

Remote On/Off

Remote turn ON/ turn OFF feature (TTL) is a standard feature of the NW Series. This feature is especially useful in portable/mobile applications where battery power conservation is critical or in applications involving high power pulsed loads where inrush currents are high.

The NW Series employs a typical TTL open collector with positive logic control pin. The voltage level at the TTL pin is referenced with respect to the converter - OUT pin. When the TTL circuit is pulled to less than 0.8 V ("logic 0") with respect to the - OUT pin, via either an open collector, or totem-pole driver, or a mechanical switch, with a 5.0mA capability, the converter shuts down. If the TTL pin is left floating or is pulled above 2.4V up to 5.0V ("logic 1") the unit will remain on. Many more devices can be used to activate the TTL pin shutdown function, consult the factory for your specific requirements.