Technical Reference Note

Embedded Power for Business-Critical Continuity

NTS500 (-M) Series

500 Watts

ITE / Medical

Total Power:	200-500 Watts
Input Voltage:	85-264 Vac
	120-300 Vdc
# of Outputs:	Single

RoHS 2002/95/EC

PMBus

Special Features

- Active power factor correction
- IEC EN61000-3-2 compliance
- Remote sense
- Power fail and remote inhibit
- Single wire current sharing
- Built-in EMI filter
- Low output ripple
- 5V standby
- 12V fan output
- Overvoltage protection
- Overload protection
- Thermal overload protection
- DC power good
- Built in OR-ing diode / FET
- Optional fan cover (-CF suffix)
- PMBus™ compliant
- Digital i^2C interface
- 2 year warranty
- POE isolation on NTS508

Safety

TUV:	60950 / 60601-1*
cCSAus:	60950 / 60601-1*
NEMKO:	60950
CB:	Certificate and report
CE:	Mark (LVD)

* Medical version

Product Descriptions

The NTS500 series power supplies are high-frequency, high density, high-performance ac-dc power supplies designed to operate with universal line inputs (85-264 Vac) at a rated continuous output power of up to 500W (with 30CFM forced air cooling) or 200W (with natural convection cooling). The power supplies meet all major safety standards (UL, CSA and VDE) and are CE marked to LVD directives. It is equipped with a multi-processor digital control system governing its over-all AC/DC conversion. A digital communication control / monitoring system using PMBus™ protocols over standard i^2C bus is provided as a standard feature.

EMERSON Network Power

Model Numbers

Standard	Medical	V1 Output Voltage	V1 Current Convection Cooling	V1 Current Force Air 30CFM	Stand-By Supply	+12V Fan Supply (+12V Fan)
NTS503	NTS503-M	12 Vdc	16.7 A	41.7 A	5V @ 2.0A	12V @ 1.0A*
NTS505	NTS505-M	24 Vdc	8.3 A	20.8 A	5V @ 2.0A	12V @ 1.0A*
NTS506	N/A	18 Vdc	11.1 A	27.8 A	5V @ 2.0A	12V @ 1.0A*
NTS508	NTS508-M	48 Vdc	4.2 A	10.4 A	5V @ 2.0A	12V @ 1.0A*

* Note: For –CF Version, 0.5A

Options

Fan Cover (-CF)

Absolute Maximum Ratings

Stress in excess of those listed in the “Absolute Maximum Ratings” may cause permanent damage to the power supply. These are stress ratings only and functional operation of the unit is not implied at these or any other conditions above those given in the operational sections of this TRN. Exposure to any absolute maximum rated condition for extended periods may adversely affect the power supply’s reliability.

Table 1. Absolute Maximum Ratings:

Parameter	Model	Symbol	Min	Typ	Max	Unit
Input Voltage:						
AC Continuous operation:	All	V_I	85	-	264	Vac
DC Continuous operation:	All	V_I	120	-	300	Vdc
Ambient Operating Temperature	All	T_A	0	-	+70	ºC
Storage Temperature	All	Tstg	–40	-	+85	ºC
Humidity:						
Operating, non-condensing	All		10	-	95	%
Non-operating, non-condensing	All		10	-	95	%
Isolation Voltage						
Input to Output	All	-	-	-	4000	Vac
Input to Safety Ground	All	-	-	-	1500	Vac
Output to Safety Ground	All	-	-	-	500	Vac

Input Specifications

Table 2. Input Specifications:

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, AC		V_{IAC}	85	115/230	264	Vac_{RMS}
Input Vac Source Frequency			47	50/60	63*/440	Hz
Operating Input Voltage, DC		V_{IDC}	120	-	300	Vdc
Maximum Input Current ($Io_{V1} = Io_{V1,max}$)	$V_I = 85V_{AC}$ $V_I = 170V_{AC}$	$I_{I,max}$	- -	- -	7.1 3.5	A_{RMS}
No Load Input Current (V1 On, $Io_{V1} = 0A$)	$V_I = 85V_{AC}$ $V_I = 170V_{AC}$	$I_{I,no\ load}$	- -	- -	300 250	mA_{RMS}
Standby Input Current (V1 Off, $Io_{5VSB} = 0$, $Io_{12V\ Fan} = 0$)	$V_I = 85V_{AC}$ $V_I = 170V_{AC}$	$I_{I,standby}$	- -	- -	180 150	mA_{RMS}
Harmonic Line Currents	All	THD	Per IEC1000-3-2			
Power Factor	All		0.9	-	-	
Startup Surge Current (Inrush) @ 25°C	$V_I = 230V_{AC}$		-	-	50	A_{PK}
Input Fuse	Internal, L and N 250V 5HFP10-R		-	-	10	A
Isolation – Input to Output Non-Medical Medical				 2500 1800		 Vdc Vac
Isolation – Input to Chassis Non-Medical Medical				 2500 1800		 Vdc Vac
Leakage Current to earth ground Non-Medical Medical	$V_I = 264V_{AC}$ $f_I = 50/60$ Hz		 - -	 - -	 500 300	 μA
PFC Switching Frequency	All	$f_{SW,PFC}$	67	-	75	KHz
DCDC Switching Frequency	All	$f_{SW,DC-DC}$	270	-	280	KHz
Operating Efficiency:@ 25°C	$V_I = 100\ V_{AC}$ $Io_{V1} = Io_{V1,max}$	η	83	-	-	%
System Stability: Phase Margin Gain Margin	330uF/A Capacitive Load		 45 10		 - -	 Ø dB

* Note: 63Hz applies to medical models only

Output Specifications

Table 3. Output Specifications:

Parameter		Condition	Symbol	Min	Typ	Max	Unit
Output Regulation:	NTS503 NTS505 NTS506 NTS508	Inclusive of temperature change, warm-up drift and dynamic load	V1	11.76 23.52 17.64 47.04	12.00 24.00 18.00 48.00	12.24 24.48 18.36 48.96	V_{DC}
	ALL		5 VSB 12V Fan	4.75 11.40	5.00 12.00	5.25 12.84	
Output Ripple, pk-pk:	NTS503 NTS505 NTS506 NTS508		V1	- - - -	- - - -	120 240 180 480	mV_{PK-PK}
	ALL		5 VSB 12V Fan	- -	- -	50 120	
Output Current, Note 1,2	NTS503 NTS505 NTS506 NTS508	Convection Cooling	Io_{V1}	0 0 0 0	- - -	16.7 8.3 11.1 4.2	A
	ALL		Io_{5VSB} $Io_{12V\ Fan}$	0 0	- -	1.0 0.5	
Output Current, Note 1,2	NTS503 NTS505 NTS506 NTS508	30 CFM Forced Air Cooling	Io_{V1}	0 0 0 0	- - -	41.7 20.8 27.8 10.4	A
	ALL		Io_{5VSB} $Io_{12\ Fan}$	0 0	- -	2.0 1.0	
V1 Output Current, peak	NTS503 NTS505 NTS506 NTS508		$Io_{V1,PK}$	- - -	47.0 23.4 30.0 11.7	- - - -	A
V1 Current Share Accuracy:				-	10	-	$\%Io_{MAX}$
V1 Minimum Current Share Loading:				20	-	-	$\%Io_{MAX}$
V1 Load Capacitance:		Startup	-	0	-	330	µF/A
V1 Dynamic Response: Peak Deviation Settling Time		50% load change, slew rate = 1A/us < ± 1%V1	±%V1 t_s	- -	- -	 3 0.5	 % mSec
V1 Long Term Stability: Max change over 24 hours		After thermal equilibrium (30 mins)	±%V1	-	-	0.1	%
V1 Temperature Coefficient:		V_I = 100 V_{AC} Io_{V1}= $Io_{V1,max}$	±%V1	-	-	0.04	%/°C

Note 1: Fan Cover Option (-CF) reduces specified $Io_{12V\ Fan}$ max limit to 0.5 amps.
Note 2: Total output power is limited to 500W, inclusive of 12V Fan and 5VSB rails.

NTS503 (-M) Performance Curves

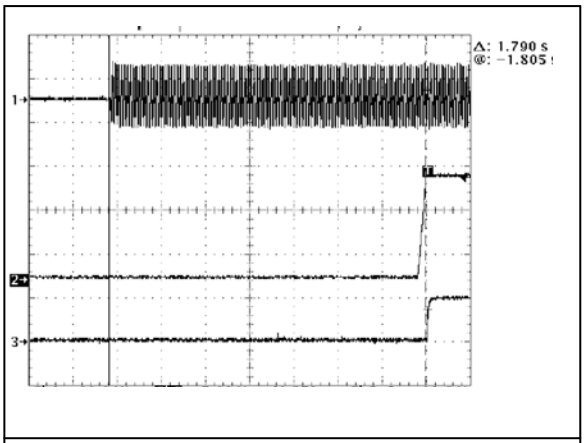


Figure 1: NTS503 (-M) Turn-on delay via AC mains - Vin = 85 Vac
Ch 1: AC Mains Ch 2: V1 Output
Ch 3: DC Power Good

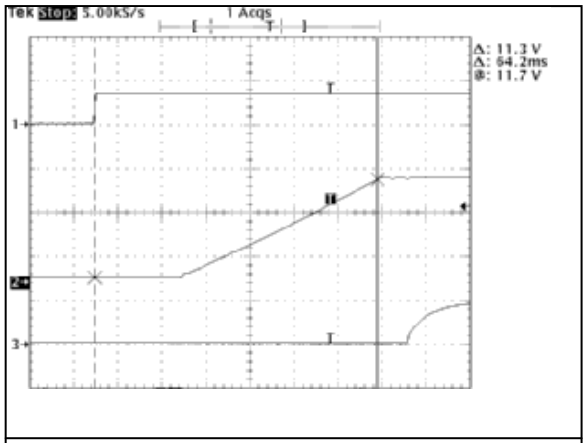


Figure 2: NTS503 (-M) Turn-on delay via Remote Inhibit - Vin = 85 Vac
Ch 1: Remote Inhibit Ch 2: V1 Output
Ch 3: DC Power Good

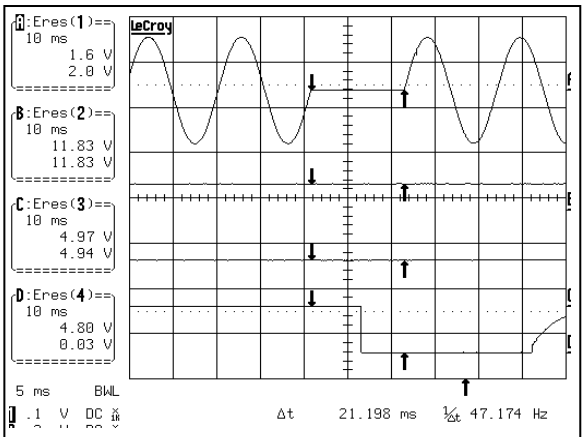


Figure 3: NTS503 (-M) Hold-up Time (Loss of AC for one cycle)
Full Load: V1 = 39.83A, 5VSB = 2A, 12V Fan = 1A
Ch 1: AC Mains Ch 2: V1 Output Ch 3: DC Power Good Ch 4: POK

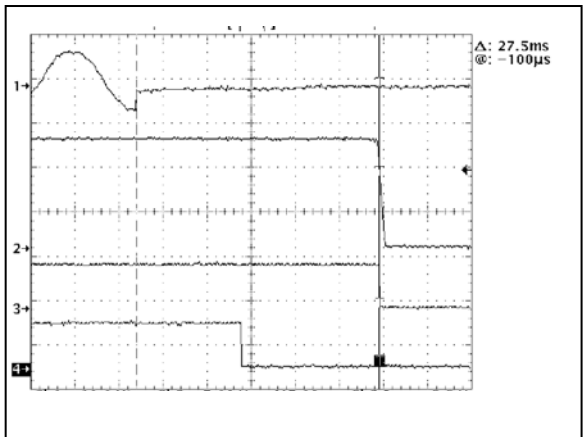


Figure 4: NTS503 (-M) Hold-up time (Time to decay)
Full Load: V1 = 41.67 A, 5VSB = 0A, 12V Fan = 0A
Ch 1: AC Mains Ch 2: V1 Output Ch 3: DC Power Good Ch 4: POK

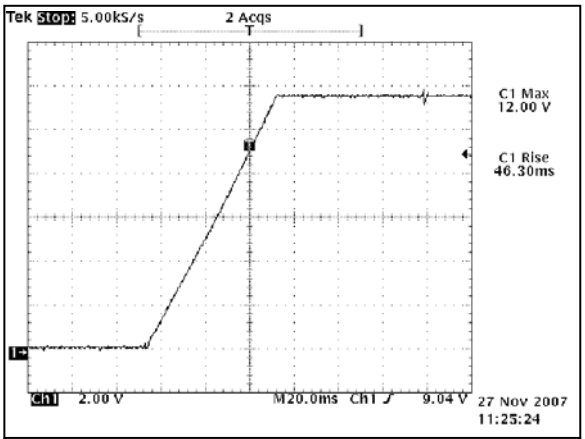


Figure 5: NTS503 (-M) Output Voltage Startup Characteristic - Vin = 85 Vac
Full Load: V1 = 41.67A, 5VSB = 0A, 12V Fan = 0A
Ch1 : V1 Output

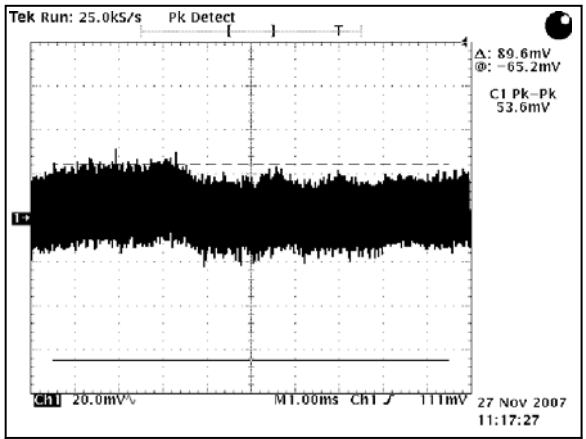


Figure 6: NTS503 (-M) Ripple and Noise Measurement – Vin = 85Vac,
Full Load: V1 = 41.67A (resistive load)
Ch 1 : V1 Output

NTS503 (-M) Performance Curves

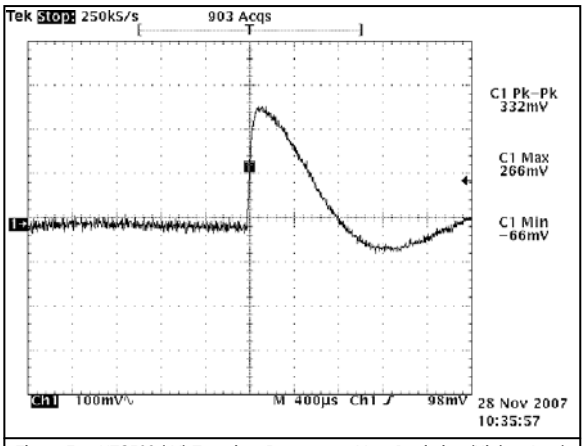


Figure 7: NTS503 (-M) Transient Response – Vout Deviation (High to Low)
50% load change 1A/us slew rate
Ch 1: V1 Output

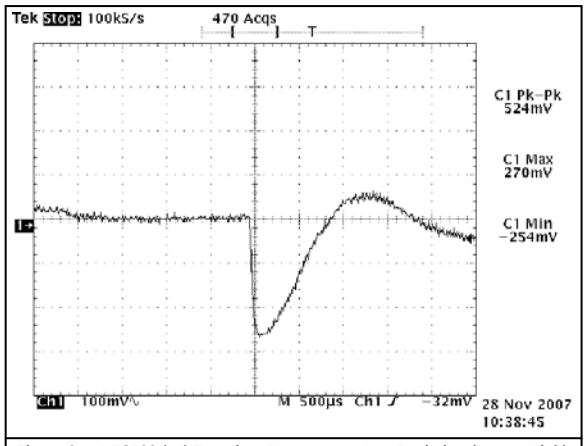


Figure 8: NTS503 (-M) Transient Response – Vout Deviation (Low to High)
50% load change 1A/us slew rate
Ch 1: V1 Output

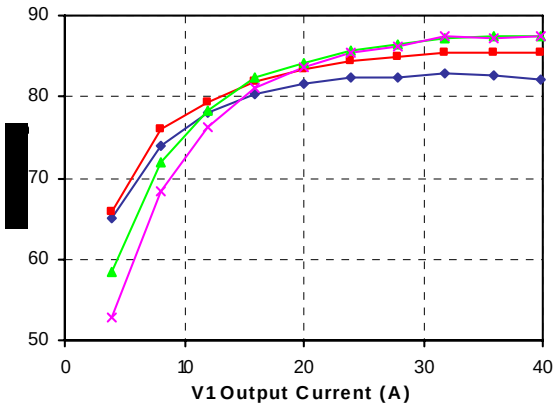


Figure 9: NTS503 (-M) Efficiency Curves @ 25 degC, 30 CFM air
85 Vac 120 Vac 230 Vac 264 Vac
Loading: V1 = 10% increment to 39.83A, 5VSB = 2A, 12V Fan = 1A

NTS505 (-M) Performance Curves

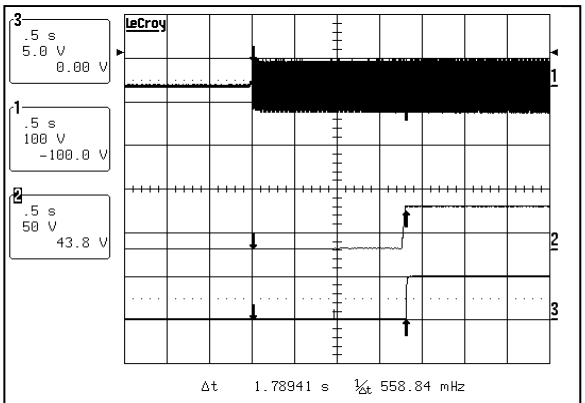


Figure 10: NTS505 (-M) Turn-on delay via AC mains - Vin = 85 Vac
Ch 1: AC Mains Ch 2: V1 Output
Ch 3: DC Power Good

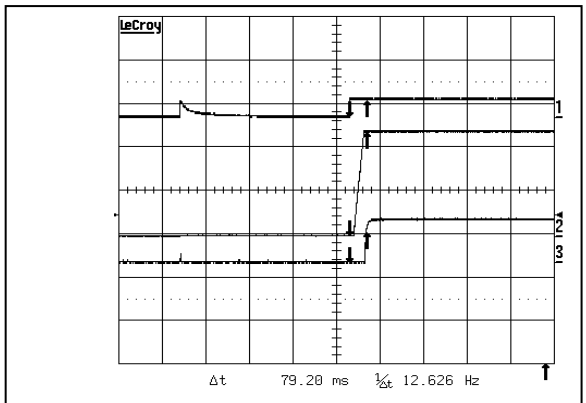


Figure 11: NTS505 (-M) Turn-on delay via Remote Inhibit - Vin = 85 Vac
Ch 1: Remote Inhibit Ch 2: V1 Output
Ch 3: DC Power Good

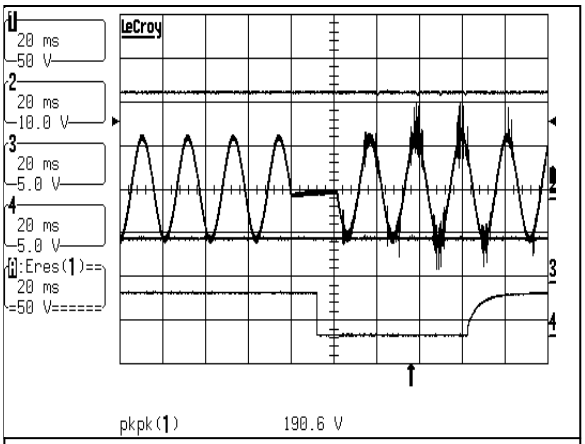


Figure 12: NTS505 (-M) Hold-up Time (Loss of AC for one cycle)
Full Load: V1 = 19.92A, 5VSB = 2A, 12V Fan = 1A
Ch 1: V1 Output Ch 2: AC Mains Ch 3: DC Power Good Ch 4: POK

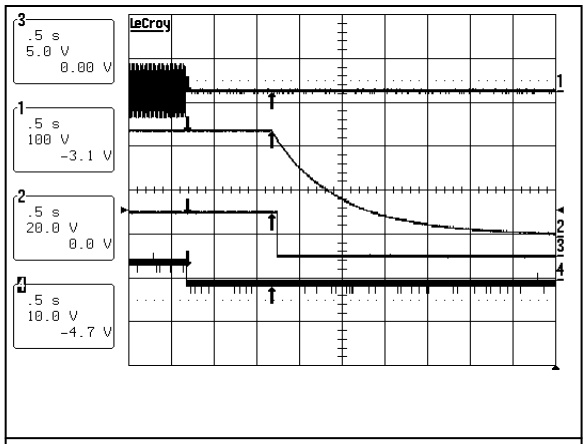


Figure 13: NTS505 (-M) Hold-up time (Time to decay)
Full Load: V1 = 20.83 A, 5VSB = 0A, 12V Fan = 0A
Ch 1: AC Mains Ch 2: V1 Output Ch 3: DC Power Good Ch 4: POK

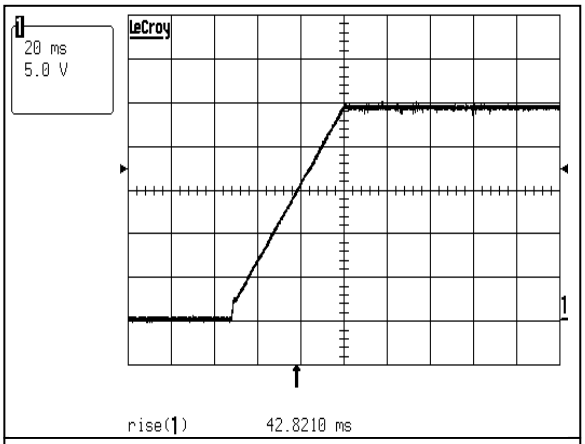


Figure 14: NTS505 (-M) Output Voltage Startup Characteristic - Vin = 85 Vac
Full Load: V1 = 20.83A, 5VSB = 0A, 12V Fan = 0A
Ch1 : V1 Output

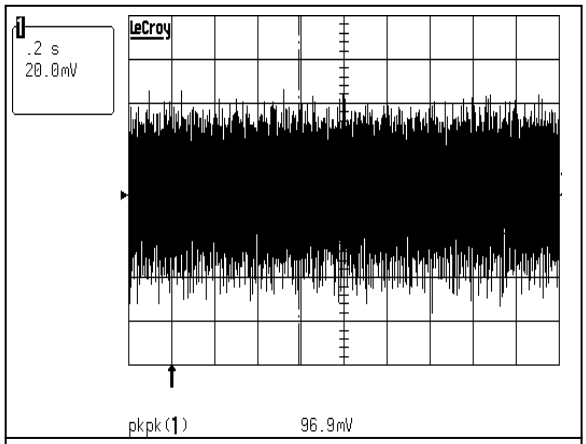


Figure 15: NTS505 (-M) Ripple and Noise Measurement – Vin = 85Vac,
Full Load: V1 = 20.83A (resistive load)
Ch 1 : V1 Output

NTS505 (-M) Performance Curves

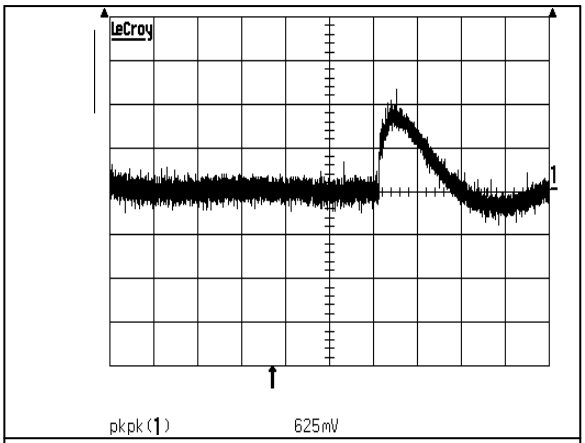


Figure 16: NTS505 (-M) Transient Response – Vout Deviation (High to Low)
50% load change 1A/us slew rate
Ch 1: V1 Output

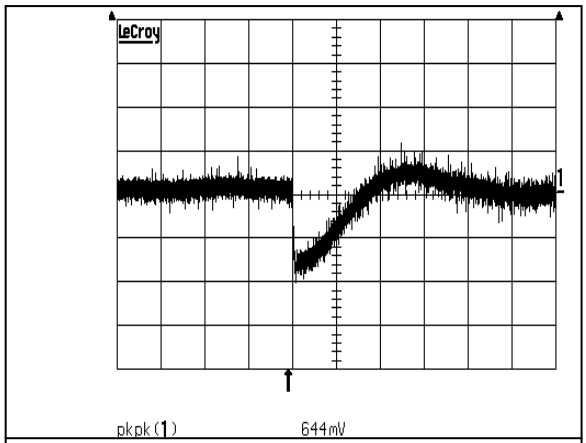


Figure 17: NTS505 (-M) Transient Response – Vout Deviation (Low to High)
50% load change 1A/us slew rate
Ch 1: V1 Output

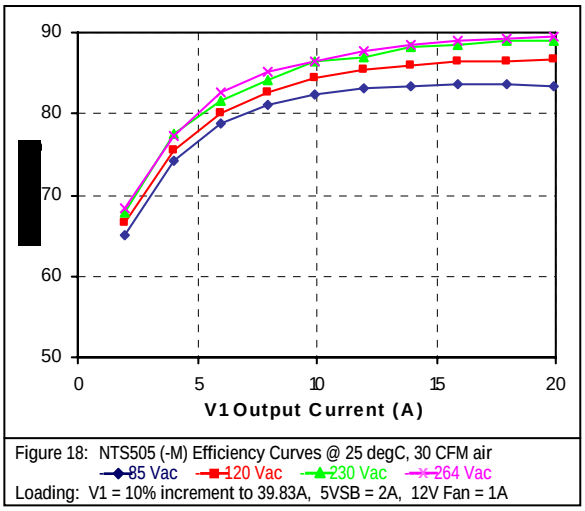


Figure 18: NTS505 (-M) Efficiency Curves @ 25 degC, 30 CFM air
85 Vac 120 Vac 230 Vac 264 Vac
Loading: V1 = 10% increment to 39.83A, 5VSB = 2A, 12V Fan = 1A

NTS508 (-M) Performance Curves

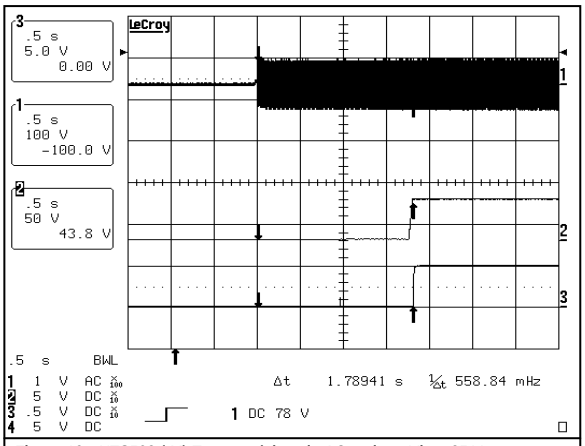


Figure 19: NTS508 (-M) Turn-on delay via AC mains - Vin = 85 Vac
Ch 1: AC Mains Ch 2: V1 Output
Ch 3: DC Power Good

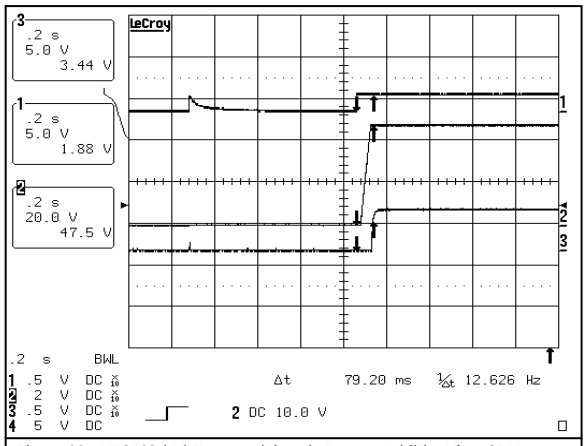


Figure 20: NTS508 (-M) Turn-on delay via Remote Inhibit - Vin = 85 Vac
Ch 1: Remote Inhibit Ch 2: V1 Output
Ch 3: DC Power Good

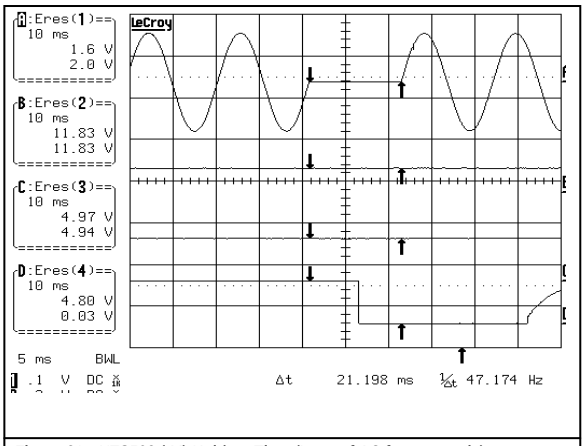


Figure 21: NTS508 (-M) Hold-up Time (Loss of AC for one cycle)
Full Load: V1 = 19.92A, 5VSB = 2A, 12V Fan = 1A
Ch 1: V1 Output Ch 2: AC Mains Ch 3: DC Power Good Ch 4: POK

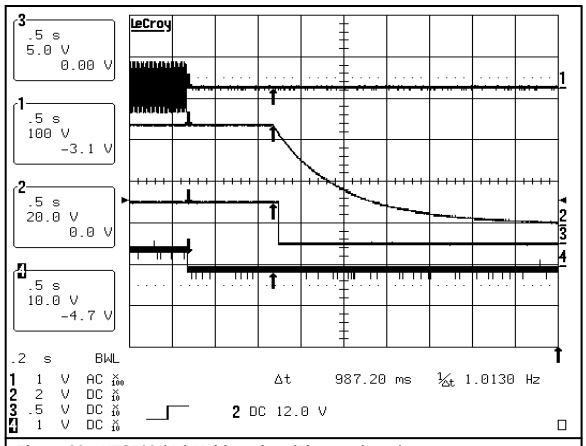


Figure 22: NTS508 (-M) Hold-up time (Time to decay)
Full Load: V1 = 20.83 A, 5VSB = 0A, 12V Fan = 0A
Ch 1: AC Mains Ch 2: V1 Output Ch 3: DC Power Good Ch 4: POK

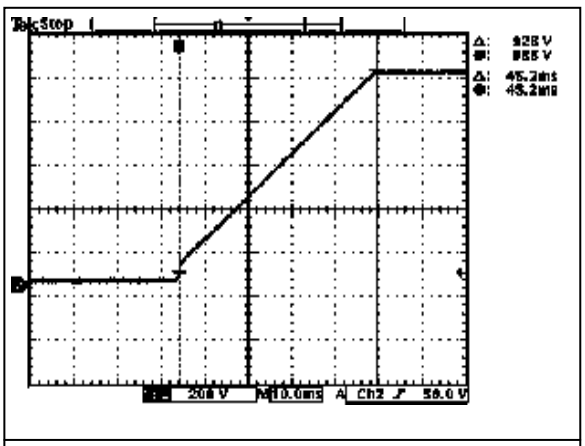


Figure 23: NTS508 (-M) Output Voltage Startup Characteristic - Vin = 85 Vac
Full Load: V1 = 20.83A, 5VSB = 0A, 12V Fan = 0A
Ch1 : V1 Output

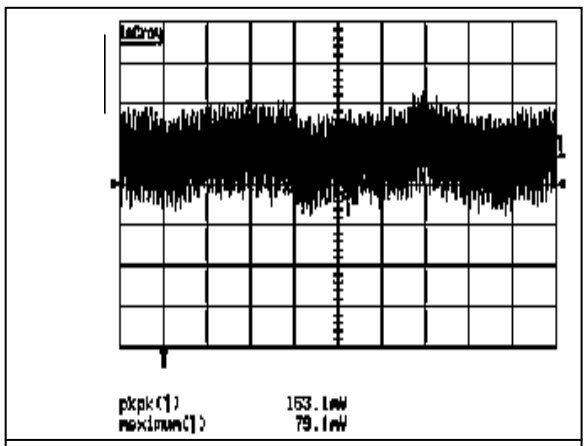


Figure 24: NTS508 (-M) Ripple and Noise Measurement – Vin = 85Vac,
Full Load: V1 = 20.83A (resistive load)
Ch 1 : V1 Output

NTS508 (-M) Performance Curves

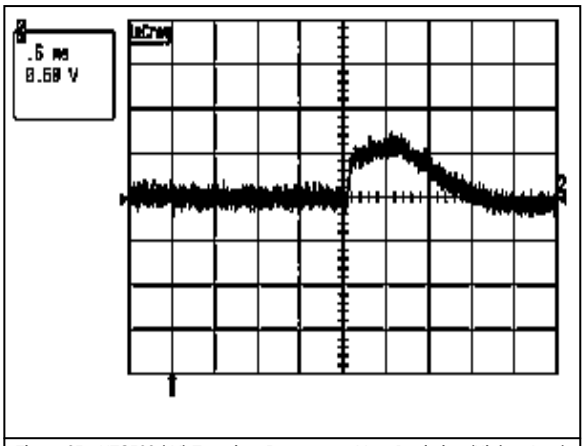


Figure 25: NTS508 (-M) Transient Response – Vout Deviation (High to Low)
50% load change 1A/us slew rate
Ch 1: V1 Output

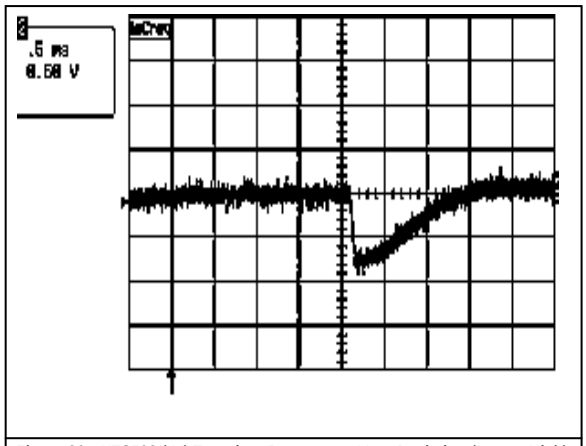


Figure 26: NTS508 (-M) Transient Response – Vout Deviation (Low to High)
50% load change 1A/us slew rate
Ch 1: V1 Output

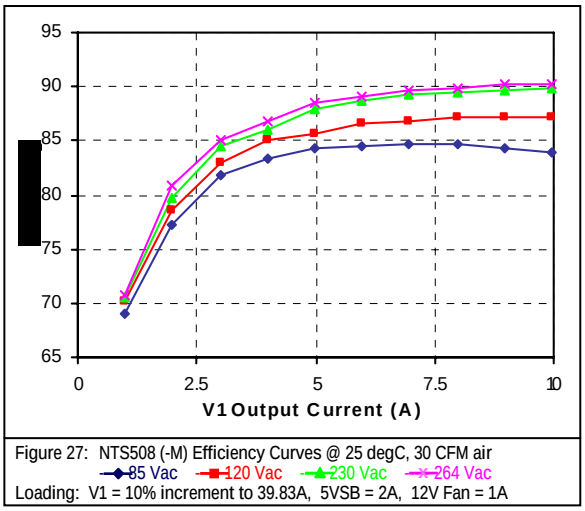


Figure 27: NTS508 (-M) Efficiency Curves @ 25 degC, 30 CFM air
85 Vac 120 Vac 230 Vac 264 Vac
Loading: V1 = 10% increment to 39.83A, 5VSB = 2A, 12V Fan = 1A

EMC Immunity

NTS500 series power supply is designed to meet the following EMC immunity specifications:

Table 4. Environmental Specifications:

Document	Description
IEC 61000-4-2	ESD up to 4 kV contact, 8kv discharge
IEC 61000-4-3	RFI 3V/m
IEC 61000-4-4	Electrical Fast Transients level 3 minimum
IEC 61000-4-5	Surge level 3 minimum
IEC 61000-4-6	Radio frequency common mode, Levels 3V (rms) Modulated AM 80%. 1 kHz, 150 ohm source imp.
IEC 61000-4-8	Power Frequency Magnetic Immunity, 1 A/m
IEC 61000-4-11	AC Input transients >95% 0.5 period 30% 25 period>95% 250 period
IEC 61000-3-2	Harmonic Distortion
ANSI 62.4	Ringwave Test 3KV at 200A

Safety Certifications

The NTS500 power supply is intended for inclusion in other equipment and the installer must ensure that it is in compliance with all the requirements of the end application. This product is only for inclusion by professional installers within other equipment and must not be operated as a stand alone product.

Table 4. Safety Certifications for NTS500 (non-medical) series power supply system

Document	Description
UL-60950-1 limited power clause latest edition	Safety of information Technology Equipment
CSA C22.2 60950-1 limited power clause latest edition	Safety of information Technology Equipment
European Community Safety (certified to EN60950, A11 May 1996)	Investigated and marketed by TUV
CCC Certified	Chinese Standard
AS 3260	Australian Standard (Approval and Test specification - Safety of Information Technology)
Australian Telecommunication Authority	Safety requirement for customer equipment, AUSTEL Technical Standard 001
CB Certificate and Report	(All CENELEC Countries)
CE Mark	LVD

Safety Certifications

The NTS500-M (Medical) series has been designed in accordance with EN 60601-1 and UL/cUL 60601-1 'Safety of Medical Equipment'.

Table 5. Safety Certifications for NTS500-M (medical) series power supply system

Document	Description
UL60601-1 (or latest)	Safety of Medical Electric Equipment
CSA-C22.2 No. 601-1	M90 medical equipment
EN60601-1 latest amendment.	European Community Safety investigated and marketed by TUV
CB Certificate and Report	(All CENELEC Countries)
CE Mark	LVD

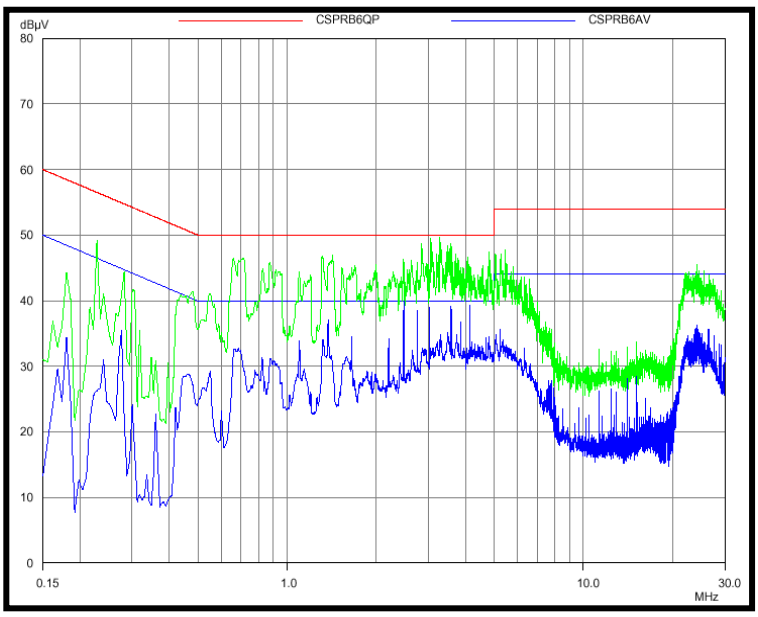
EMI Emissions

The NTS500 series has been designed to comply with the Class B limits of EMI requirements of EN55022 (FCC Part 15) and CISPR 22 (EN55022) for emissions and relevant sections of EN61000 (IEC 61000) for immunity.

The unit is enclosed inside a metal box with 300 X 322.5 X 45mm dimension, tested at 500W using resistive load with cooling fan. Two turns of wire from AC Live & Neutral wound on a Ferrite sleeve with manufacturer part number BRH17.5x28.5x9.5 from Chilisin Electronics or equivalent were used.

Conducted Emissions

The applicable standard for conducted emissions is EN55022 (FCC Part 15). Conducted noise can appear as both differential mode and common mode noise currents. Differential mode noise is measured between the two input lines, with the major components occurring at the supply fundamental switching frequency and its harmonics. Common mode noise, a contributor to both radiated emissions and input conducted emissions, is measured between the input lines and system ground and can be broadband in nature.



The NTS500 power supplies have internal EMI filters to ensure the convertors' conducted EMI levels comply with EN55022 (FCC Part 15) Class B and EN55022 (CISPR 22) Class B limits. The EMI measurements are performed with resistive loads under forced air convection at maximum rated loading.

Sample of EN55022 Conducted EMI Measurement at 100Vac input

Note: Red Line refers to Emerson Quasi Peak margin, which is 6dB below the CISPR international limit. Blue Line refers to the Emerson Average margin, which is 6dB below the CISPR international limit.

Conducted Emissions

Table 6. Conducted EMI emission specifications of the NTS500 (-M) series

Parameter	Model	Symbol	Min	Typ	Max	Unit
FCC Part 15, class B	All	Margin	-	-	6	dB
VCCI Class II	All	Margin	-	-	6	dB
EN 60601-1-2: 2001	All	Margin	-	-	6	dB
CISPR 22 (EN55022) class B	All	Margin	-	-	6	dB

Radiated Emissions

Unlike conducted EMI, radiated EMI performance in a system environment may differ drastically from that in a stand-alone power supply. The shielding effect provided by the system enclosure may bring the EMI level from Class A to Class B. It is thus recommended that radiated EMI be evaluated in a system environment. The applicable standard is EN55022 Class A (FCC Part 15). Testing ac-dc convertors as a stand-alone component to the exact requirements of EN55022 can be difficult, because the standard calls for 1m leads to be attached to the input and outputs and aligned such as to maximize the disturbance. In such a set-up, it is possible to form a perfect dipole antenna that very few ac-dc convertors could pass. However, the standard also states that 'an attempt should be made to maximize the disturbance consistent with the typical application by varying the configuration of the test sample'.

Operating Temperature

The NTS500 series power supplies will start and operate within stated specifications at an ambient temperature from 0 °C to 50 °C under all load conditions with 30CFM of cooling air (see below derating curves for other amount of air flow and orientation. Derate output current and power by 2.5% per °C above 50 °C. Maximum operating ambient temperature is 70 °C (which implies a 50% derating at max 70 °C ambient). Under convection cooling condition, the maximum output power derates linearly from 200 Watts.

Derating Curves

Both the ambient operating temperature and the method of cooling will limit the maximum power available from the NTS500 Series power supply.

Forced Air Cooling

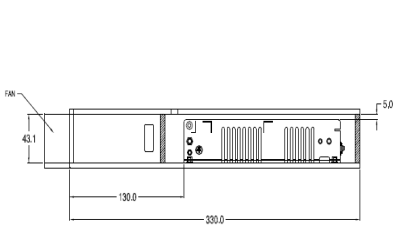
The NTS500 series will provide 500W output with 30CFM of forced air cooling for ambient temperature upto 50 degC. Above 50 degC, it will require a derating of 2.5% output power per degC for operation upto 70 degC.

Forced Air Cooling set up:
Load = 100% of forced air load (500W)
Cooling Fan: Use one cooling fan with 30CFM air flow rating blowing lengthwise or sideways.
(Refer to Set-up 1 to 4).

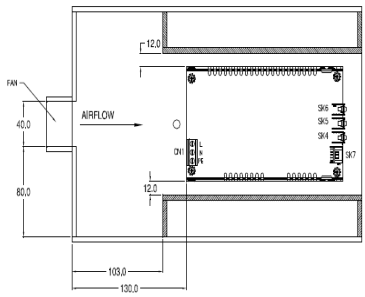
Forced Air Cooling Derating Curves

Below are the derating curves for NTS500 series for each of the 4 forced air cooling set up configurations. Please note that these curves are valid for ambient temperature upto 50 degC. For operation at higher ambient temperature upto 70 degC, the maximum output power must be de-rated at a rate of 2.5% per degC.

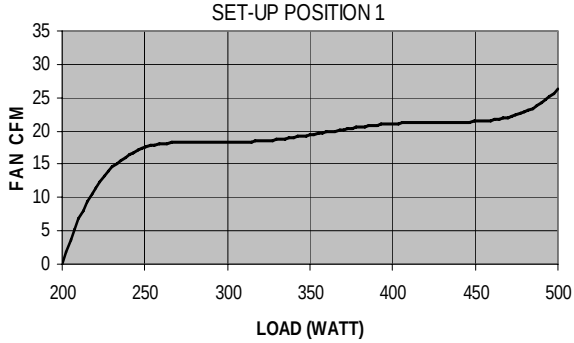
SET-UP 1



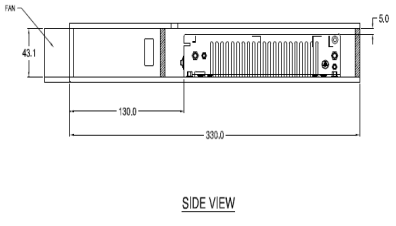
SIDE VIEW



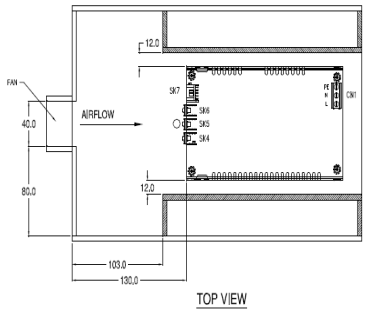
TOP VIEW



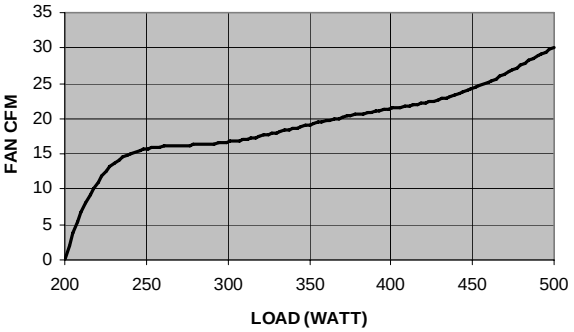
SET-UP 2



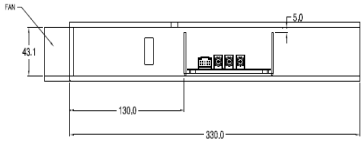
SIDE VIEW



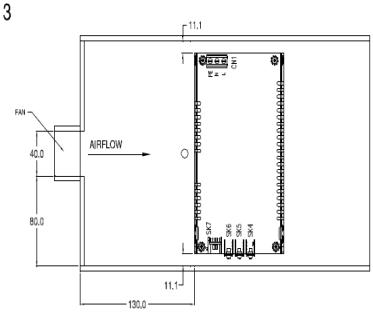
TOP VIEW



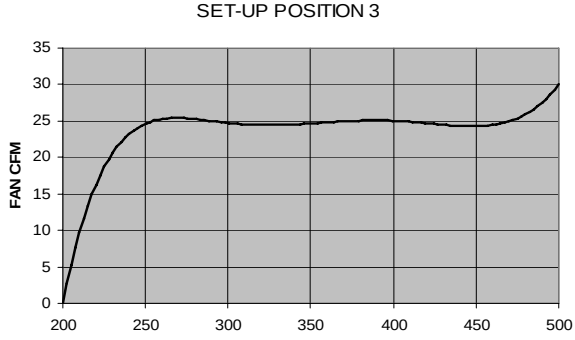
SET-UP 3



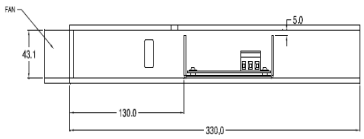
SIDE VIEW



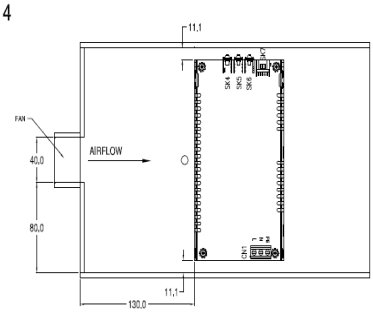
TOP VIEW



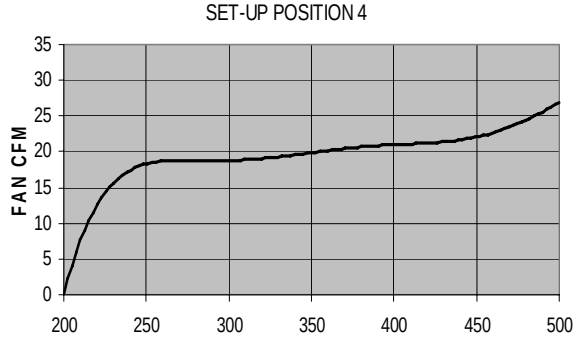
SET-UP 4



SIDE VIEW



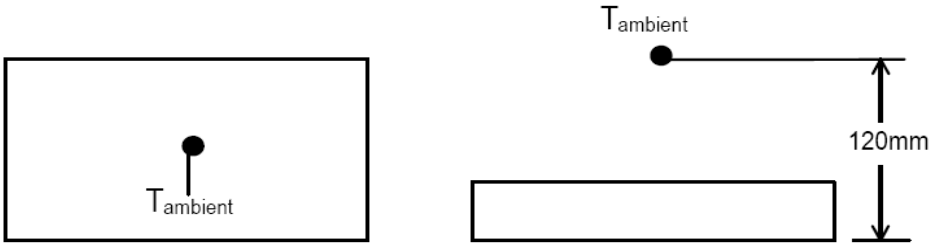
TOP VIEW



Natural Convection Cooling

The NTS500 series will provide upto 200W output power under natural convection condition for ambient temperature upto 50 degC. Above 50 degC, it will require a derating of 2.5% output power per degC for operation upto 70 degC.

Natural convection cooling defined as power supply unit mounting on flat surface with bottom of U-Channel down and open top unrestricted setting (see diagram below). Other mounting orientation might produce different derating and should be evaluated.



Top View Side view

Storage and Shipping Temperature / Humidity

The NTS500 series power supplies can be stored or shipped at temperatures between –40 °C to +85 °C and relative humidity from 5% to 95% non-condensing.

Altitude

The NTS500 series will operate within specifications at altitudes from –500 to 10,000 feet above sea level. The power supply shall not be damaged when stored at altitudes of –1,000 to 50,000 feet above sea level.

Humidity

The NTS500 series will operate within specifications when subjected to a relative humidity from 10% to 95% non-condensing.

Shock

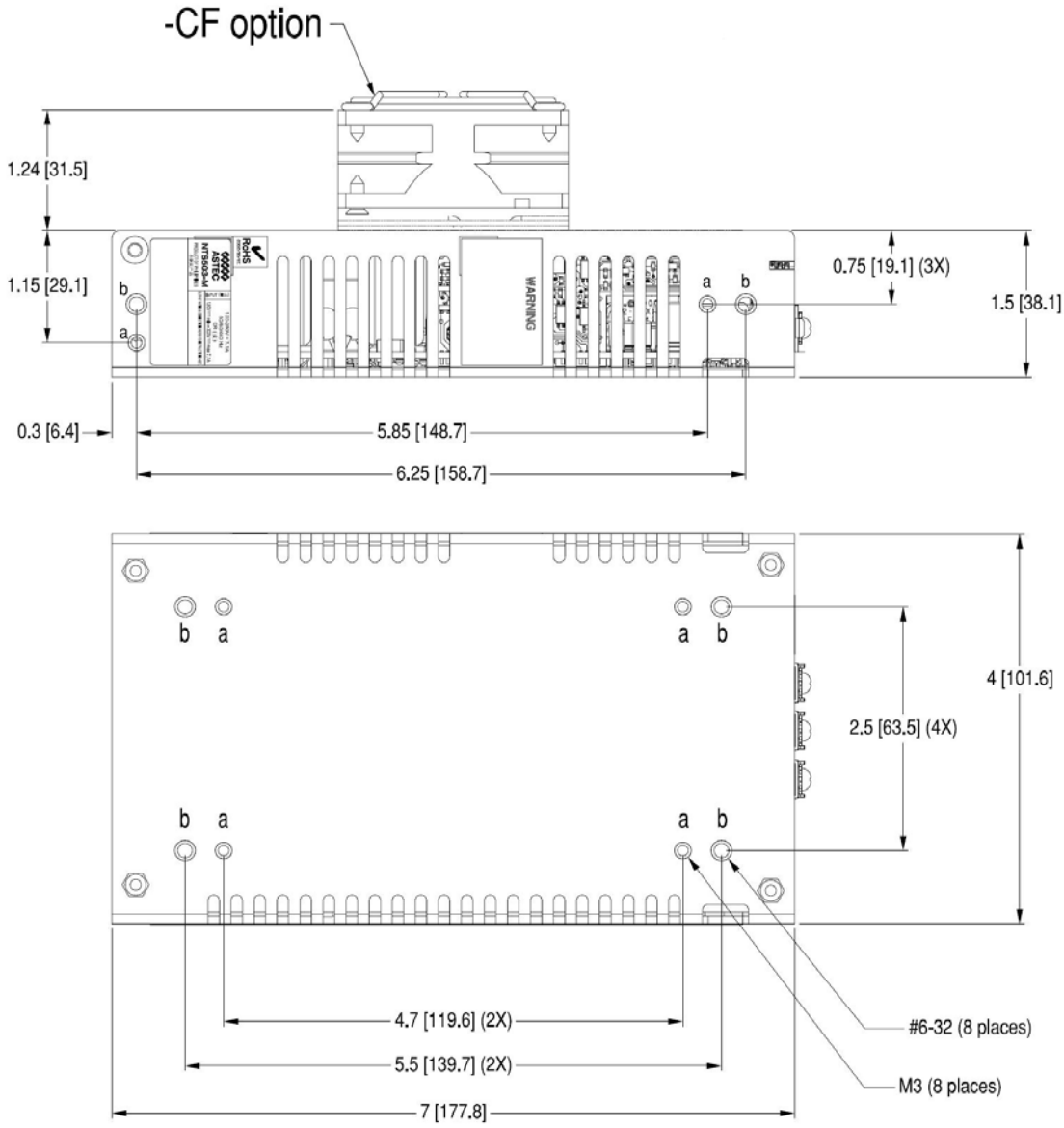
The power supplies will pass shock test of 30 G rms, half sine, 11 ms, allowing for one drop on each of the six faces.

Vibration

The power supplies, while not operating, will withstand random vibrations in 3 orthogonal axes, 1 octave per minute. One sweep is 2 Hz to 500 Hz for 10 minutes each axis.

AMP/DISP	FREQ	NOTES
7.5 mil	2-8 Hz	x,y,z
2G's	8-200 Hz	x,y,z
4G's	200-500 Hz	x,y,z

Mechanical Drawing (Dimensioning and Mounting Locations)

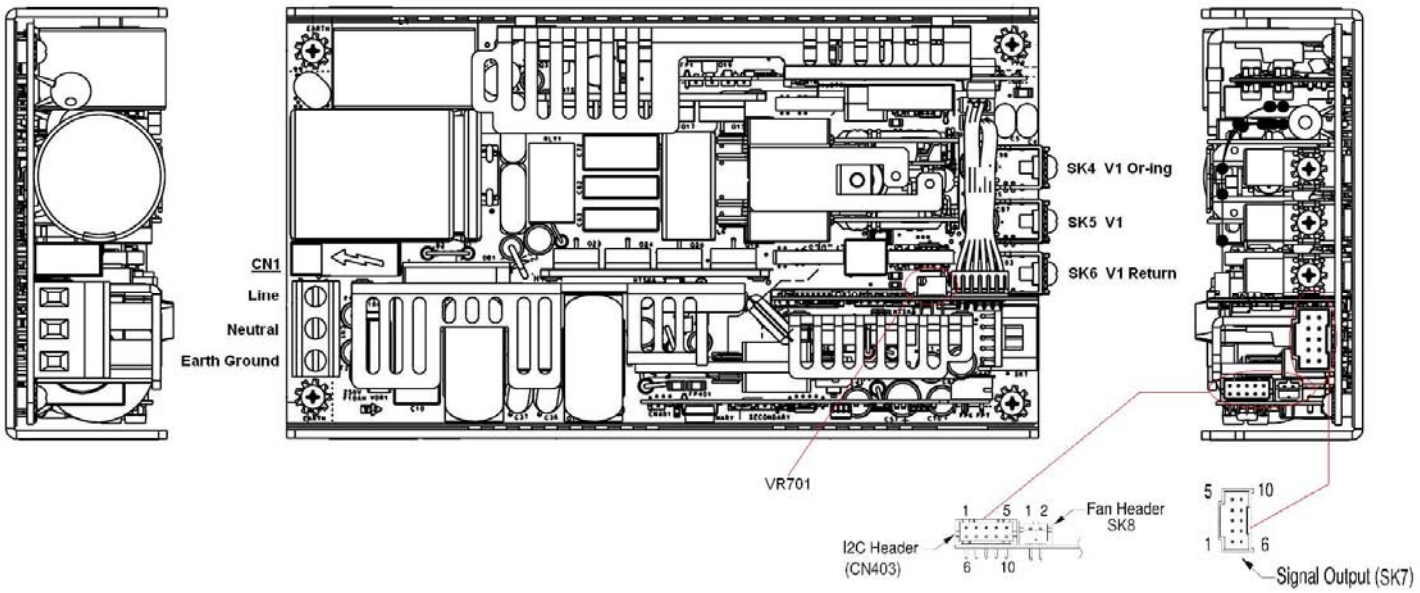


All dimensions in inches [mm], tolerance is +/-0.02" [0.5mm]

Chassis Mounting

The NTS500 Series has threaded mounting provisions incorporated into both the sides and the bottom of its U channel chassis using either standard or metric hardware. Refer to above drawing for the mounting locations. Maximum screw insertion depth (penetration) is limited to 0.12" (3.0 mm) and the maximum torque that can be applied to the hardware is 5 lbs/inch (0.56 N)

Mechanical Drawing (Connector and Potentiometer Locations)



Connector Definitions

AC Input Connector – CN1

Pin 1 – Line
Pin 2 – Neutral
Pin 3 – Earth Ground

Output Connector – SK4-6

SK4 – V1 Or-ing
SK5 – V1
SK6 – V1 Return

Control Signal Header – SK7

Pin 1 – V1 SWP
Pin 2 – -Remote Sense
Pin 3 – +Remote Sense
Pin 4 – 5 VSB
Pin 5 – GND
Pin 6 – +12V FAN
Pin 7 – Fan GND
Pin 8 – Remote Inhibit
Pin 9 – DC Power Good
Pin 10 – Power Fail (POK)

Fan Header – SK8

Pin 1 – +12V Fan
Pin 2 – Fan GND

I²C Header (PMBus™ Interface) – CN403

Pin 1 – 5V_I2C
Pin 2 – GND
Pin 3 – A2
Pin 4 – A0*
Pin 5 – SVCC2_OR**
Pin 6 – I2C_SDA
Pin 7 – I2C_SCL
Pin 8 – A1
Pin 9 – N/C
Pin 10 – +12V_RTN_CTRL***

Note:
* Pin 4 will be N/C for NTS508 (+48V Variant)
** Pin 5 of all PSU's must be connected during redundant operation
*** Pin 10 of all PSU's must be connected during redundant operation

Power / Signal Mating Connectors and Pin Types

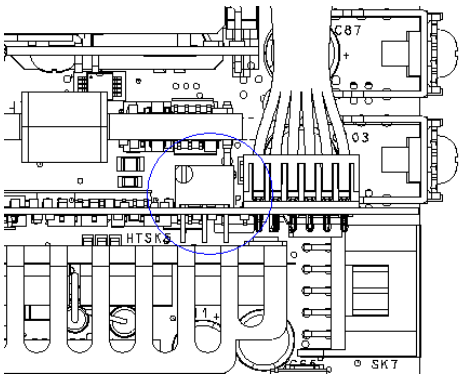
Table 7. Mating Connectors for NTS500 (-M) series

Reference	Vendor	Mating Connector or Equivalent	Mating Pins/Terminals or Equivalent
CN1	Terminal Block	No mating needed	
SK4,5,6	M3.5x6 Screw	#8 Terminal Lug	
SK7	Molex	90142-0010	90119-2110
CN403	JST	PHDR-10VS	SPHD-002T-PO.5-L/P
SK8	JST	PHR-2	SPH-002T-P0.5S

NTS500 connector kit can be order separately from Emerson. Use Connector Kit # 70-841-024 to order. Each NTS500 connector kit contains the following:

- 4pcs Molex 19141-0058 #8 spade terminal lug (14-16 AWG wire) for SK4, SK5, SK6
- 1pcs Molex 90142-0010 header connector housing for SK7
- 11pcs Molex 90119-2110 crimp pins for Molex 90142-0010
- 1pcs JST PHDR-10VS header housing for CN403
- 9pcs JST SPHD-002T-PO.5-L/P crimp pins for JST PHDR-10VS
- 1pcs JST PHR-2 header housing for SK8
- 3pcs JST SPH-002T-P0.5S crimp pins for JST PHR-2

Potentiometer Definitions



VR701- V1 Output adjust

Weight

The NTS500 (-M) series weight is 3.0 lbs. maximum.

AC Input (CN1)

This connector supplies the AC Mains to the NTS500 power supply.

Pin 1 - Line
Pin 2 - Neutral
Pin 3 - Earth Ground

Main Output (SK4 – SK6)

These terminals provide the main output for the NTS500. The V1 and the V1 Return terminals are the positive and negative rails, respectively, of the V1 main output of the NTS500 power supply. The V1 OR-ing terminal provides the V1 rail with a series OR-ing diode (FET) to protect the system for N+1 applications. The Main Output is electrically isolated from the power supply chassis (U channel).

SK4 - V1 ORing
SK5 - V1
SK6 - V1 Return

V1 Output voltage adjustment

Manual Adjustment

The main output of the NTS500 series can be adjusted by +/- 5% of its nominal output voltage via the potentiometer VR701.

Digital Adjustment

The power supply's V1 output can also be adjusted through the included I^2C port via the PMBus™ interface. The range of adjustment is the same +/-5% window around the nominal voltage as given in the manual adjustment section. Please see the I^2C interface section for instructions on adjusting the output voltage digitally.

Note: Potentiometer VR701 must be set to the original factory setting in order for the digital adjustment to operate correctly.

Control Signals (SK7)

The NTS500 series contains a 10 pins control signal header providing analogy control interface and standby power interface.

V1 SWP (Single Wire Parallel) – (SK7 – Pin 1)

The NTS500 supports active current sharing through a single wire connection between the power supplies. The SWP pin allows up to 3 additional units to be paralleled to increase the overall power capability or to operate the units in an N+1 configuration for redundancy purposes.

+Remote Sense, -Remote Sense (Remote Sensing) – (SK7 – Pin 2 and Pin 3)

The main output of the NTS503 is equipped with a Remote Sensing capability that will compensate for a voltage drop of up to a 0.5V between the output terminals of the supply and the sensed voltage point (load). This feature is implemented by connecting the V1 +Remote Sense (pin 3) and the V1 –Remote Sense (pin 2) terminals to the positive and negative rails of the main output, respectively, at a location that is near to the load. Care should be taken in the routing of the sense lines as any noise sources or additional filtering components introduced into the voltage rail may affect the stability of the power supply. The NTS500 will operate appropriately without the sense lines connected; however it is recommended that the sense lines be connected directly to the main output terminals if remote sensing is not required.

The power supply is protected against damage caused by inadvertent reverse connection of the Remote Sense lines.

Remote sensing has no effect on the Standby Voltage (5 VSB) or the 12V Fan outputs.

Note: The maximum output voltage from the main rail of the NTS500 series is limited to 5% above the nominal setting, trimming the main output above the nominal may limit the maximum amount of voltage sense compensation.

5 VSB (Standby Output) – (SK7 – Pin 4)

The NTS500 provides a regulated 5 volt 2 amp auxiliary output voltage to power critical circuitry that must remain active regardless of the on/off status of the power supply's main output. The 5 VSB standby voltage is available whenever a valid AC input voltage is applied to the unit. The 5 VSB output is independently short circuit protected and is referenced to the GND pin (SK7 – Pin 5).

GND (Ground Reference) – (SK7 – Pin 5)

This pin is the secondary side logic ground reference for all the control signals and power return for the 5VSB standby output in the SK7 control header. It is electrically connected to the main output V1 Return.

+12V Fan (+12V Fan Supply Output) – (SK7 – Pin 6)

The NTS500 provides a regulated 12 volt 1 amp auxiliary output voltage for Fan supply use that must remain active regardless of the on/off status of the power supply's main output. The +12V Fan supply voltage is available whenever a valid AC input voltage is applied to the unit. The +12V Fan output is independently short circuit protected. It is the same output as the Fan Header SK8 – Pin 2 (ie, the total current between the two +12V fan outputs must be less than 1A total). The +12V Fan output is referenced to the Fan GND pin (SK7 – Pin 7).

Fan GND (+12V Fan Output Return) – (SK7 – Pin 7)

This pin is the power return for the +12V Fan output. It is electrically connected to the main output V1 Return.

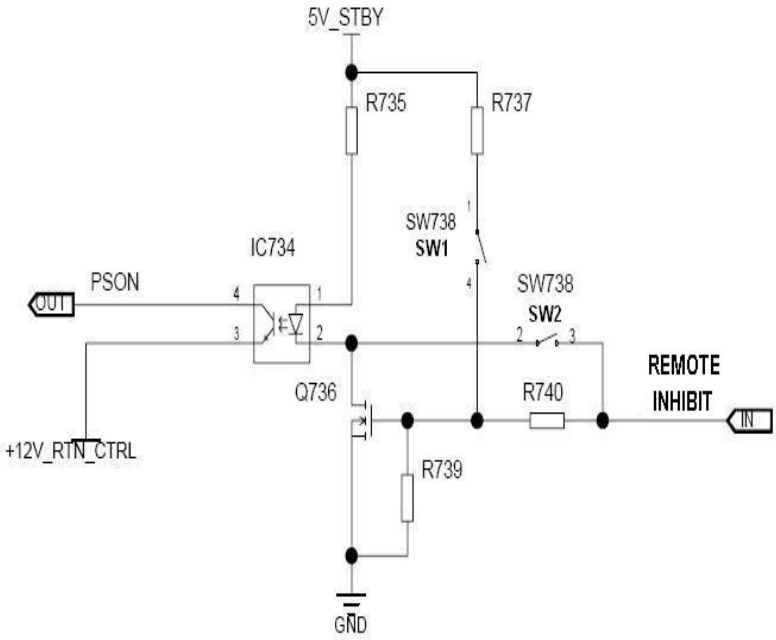
Remote Inhibit – (SK7 – Pin 8)

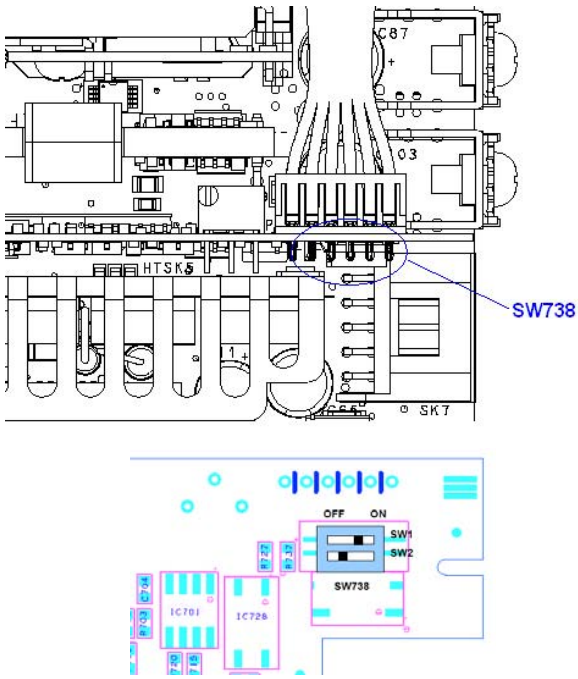
Remote Inhibit is a TTL compatible active low input pin that allows the system or user to control the operating state of the NTS500 power supply. During application of an inhibit condition, the main output will be disabled however the 5VSB and the +12V Fan output will continue to be available. The Remote Inhibit input is referenced to the GND pin (SK7 – Pin 5).

The Remote Inhibit can be set to either normally open or normally close. Dip-switch (SW738) programs the Inhibit Pin. The default factory setting is normally open – TTL low input (or short to GND) to turn off the main output V1. A TTL high input (or open pin) at the Remote Inhibit will turn on the main output V1

The factory default settings of dip-switch SW738-SW1 = ON.

To program the Remote Inhibit as normally close, set the dip-switch to SW738-SW1 = OFF. In normally close state, open pin at the Remote Inhibit will turn off the main output V1.





DC Power Good – (SK7 – Pin 9)

The DC Power Good (DC OK) output pin indicates the readiness of the power supply's main output rail. It is an active HIGH TTL logic signal that is asserted within 10 ms after the main output is within +/-5% of the regulation set point.

Power Fail (POK) – (SK7 – Pin 10)

Power Fail (POK) is a TTL compatible signal that conforms to the following conditions:

Low to High Transition (POK)

Mains AC Application - Delay measurement between the application of the Mains AC at the power supply input to the availability of the regulated V1 output without the effect of the Inhibit signal. AC line should be considered at 90 degrees at time of initial application to the power supply input.

Inhibit - Delay measurement between the removal of the inhibit signal with the Mains AC applied previously to the availability of the regulated V1 output.

High to Low Transition (Power Fail)

The high to low transition of the Power Fail (POK) signal shall be an indication of the impending loss of V1 regulation due to a shutdown condition such as the loss of Mains AC, output Overvoltage Protection or Over Temperature Protection. The AC line should be considered at 0 degrees at the time of removal from the power supply input.

Timing Relationships for Turn-On Delay, DC Power Good and Power Fail (POK)

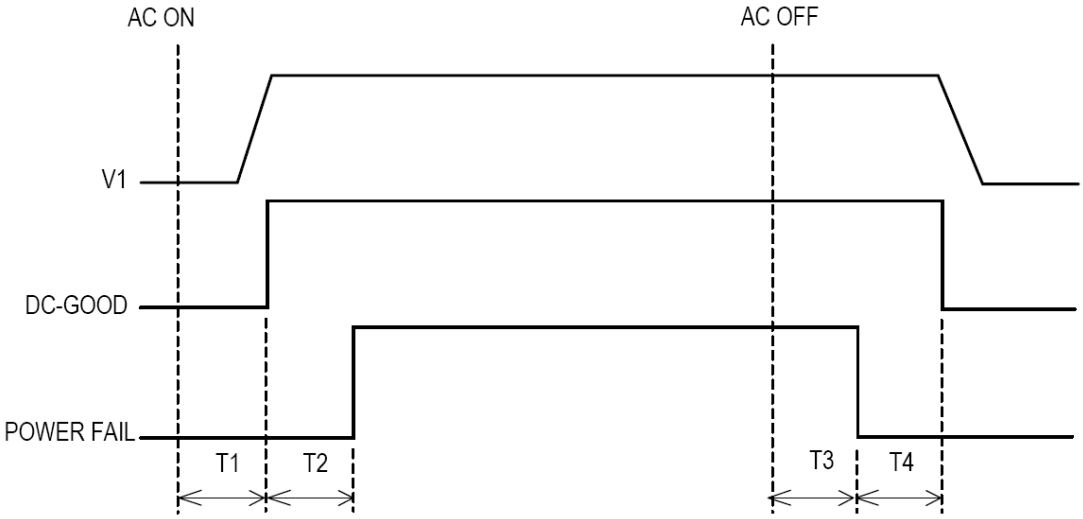


Table 8. Electrical and timing specifications of the Control Signals (referenced to GND pin, unless otherwise indicated):

Parameter	Condition	Symbol	Min	Typ	Max	Unit
TTL output signals; DC Power Good, Power Fail (POK)	 High State Low State		 4.75 -	 - -	 - 0.8	V
TTL output sinking capability	Low State (0.5V)				10	mA
Inhibit Signal, Input	High State Low State		4.75 -		- 0.8	V
DC Power Good (T1): Mains AC application Enable/Inhibit	V_I = 100Vac Io_{V1}= $Io_{V1,max}$	ton_{delay}	 - -	 - -	 2 0.2	S
Power Fail Delay (T2) Power Fail (POK) Low to High transition	V_I = 100Vac Io_{V1}= $Io_{V1,max}$		100		500	ms
Power Fail Warning (T3) Power Fail (POK) High to Low transition	V_I = 100Vac Io_{V1}= $Io_{V1,max}$		10	-	-	ms
Power Fail (T4) DC Good High to Low transition	V_I = 100Vac Io_{V1}= $Io_{V1,max}$		10	-	-	ms
Output Hold Up Time (T3+T4)	V_I = 100Vac Io_{V1}= $Io_{V1,max}$		20	-	-	ms

Fan Header (SK8)

The Fan Header provides a –5%/+7% regulated 12 volt 1 amp auxiliary voltage between pins 1 and 2 for the purpose of driving an external DC fan. The Fan Voltage is always active and is independently short circuit protected.

When the Fan Cover option (-CF) is selected the available current from the Fan Voltage Output is reduced to 0.5 amps.

+12V Fan (+12V Fan Supply Output) – (SK8 – Pin 1)

The NTS500 provides a regulated 12 volt 1 amp auxiliary output voltage for Fan supply use that must remain active regardless of the on/off status of the power supply's main output. The +12V Fan supply voltage is available whenever a valid AC input voltage is applied to the unit. The +12V Fan output is independently short circuit protected. It is the same output as the Control Signals SK7 – Pin 6 (ie, the total current between the two +12V fan outputs must be less than 1A total). The +12V Fan output is referenced to the Fan GND pin (SK8 – Pin 2).

Fan GND (+12V Fan Output Return) – (SK8 – Pin 2)

This pin is the power return for the +12V Fan output. It is electrically connected to the main output V1 Return.

With Fan Cover Option (–CF), the SK8 header will be occupied by the integrated fan.

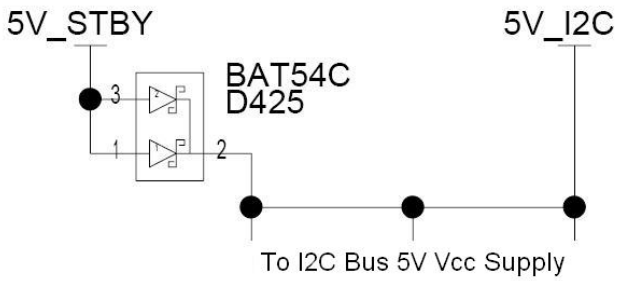
I2C™ Signals (CN403)

The NTS500 Series I2CTM functionality (PMBus™ and FRU data) can be accessed via the CN403 header. The communication bus is powered either by the internal 5V standby supply or by using an external 5V power source connected to (5V_I2C) of Pin 1 - CN403 header.

Note: PMBus™ functionality can be accessed only when the PSU is powered-up.
Guaranteed communication I2CTM speed is 100KHz.

5V_I2C (5V Or-ed Supply) – (CN403 – Pin 1)

The 5V_I2C pin supplies power to the I2C communication circuitry in the NTS500 series power supply. It is connected to the internal 5V standby supply via an or'ing diode. When using the NTS500 series in a single power supply configuration, the I2C™ communication bus is available whenever a valid AC input voltage is applied to the unit. Alternatively, an external 5V can be connected to this pin to power up this circuitry.



When multiple NTS500 series power supplies are used together in parallel or redundancy configurations, the 5V_I2C pins should be connected together such that if one unit has valid AC voltage applied, all units' I2CTM communication bus will be available. This will allow the status & FRU data to be read from a supply that is not powered on, or has some other fault.

GND (Ground Reference) – (CN403 – Pin 2)

This pin is the secondary side logic ground reference for all I2CTM communication bus signals in the CN403 header. It is electrically connected to the main output V1 Return

A2 (Address Pin 2) – (CN403 – Pin 3)

This is the power supply slot ID bit A2. It is internally pulled up to 5V_I2C with a 4K7 resistor.

A0 (Address Pin 0) – (CN403 – Pin 4)

This is the power supply slot ID bit A0. It is internally pulled up to 5V_I2C with a 4K7 resistor. On NTS508 (48V output) model, this pin is internally disconnected (N/C).

SVCC2_OR (Internal Or-ed Supply) – (CN403 – Pin 5)

When multiple NTS500 series power supplies are used together in parallel or redundancy configurations, this pin must be connected together between all paralleled power supplies.

I2C_SDA (Serial Data) – (CN403 – Pin 6)

I2C™ serial data bus - this pin is internally pulled up to 5V_I2C with a 39K resistor and an 82pF noise filter capacitor connected to GND.

I2C_SCL (Serial Clock) – (CN403 – Pin 7)

I2C™ serial clock bus - this pin is internally pulled up to 5V_I2C with a 39K resistor and an 82pF noise filter capacitor connected to GND.

A1 (Address Pin 1) – (CN403 – Pin 8)

This is the power supply slot ID bit A1. It is internally pulled up to 5V_I2C with a 4K7 resistor.

N/C – (CN403 – Pin 9)

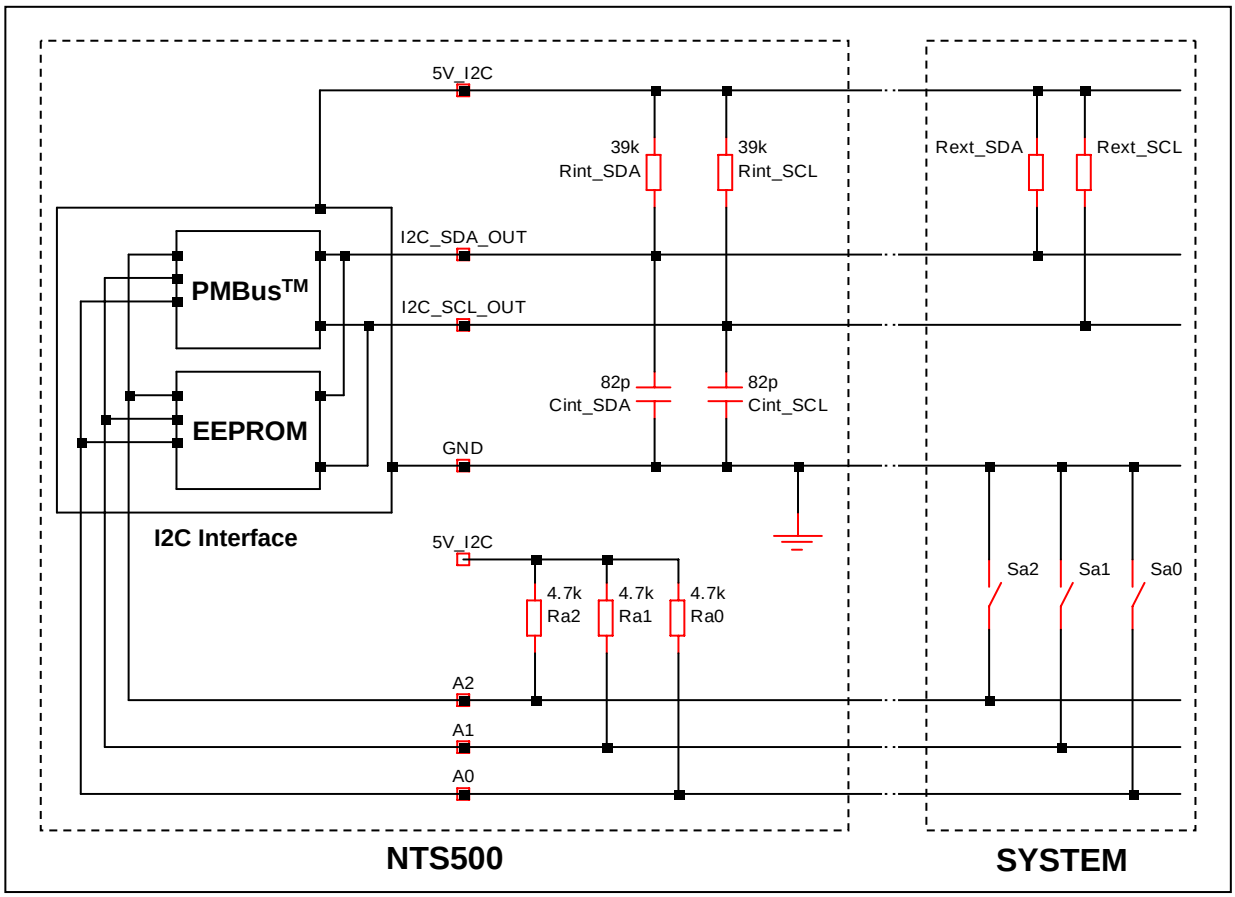
+12V_RTN_CTRL (Internal ground) – (CN403 – Pin 10)

When multiple NTS500 series power supplies are used together in parallel or redundancy configurations, this pin must be connected together between all paralleled power supplies.

Table 9. Electrical and Interface specifications of I2C™ signals (referenced to GND pin, unless otherwise indicated):

Parameter	Condition	Symbol	Min	Typ	Max	Unit
SCL, SDA internal pull-up resistor, R_{int}				39		Kohm
SCL, SDA internal bus capacitance, C_{int}				82		pF
Total I^2C line Pull-up (SDA/SCL), $R_p = R_{int} \parallel R_{ext}$	V_{HI} = 5V V_{LO} = 0.4V $I_{SINK(MAX)}$ = 3mA		1.6	-	-	Kohm

I²C Bus Internal Implementation, Pull-ups and Bus Capacitances



Recommended external pull-ups:

Configuration	Internal	Recommended External Pull-up
1 PSU	39kohm	1.8kohm
8 PSU's (max)	4.875kohm (combined)	2.7kohm

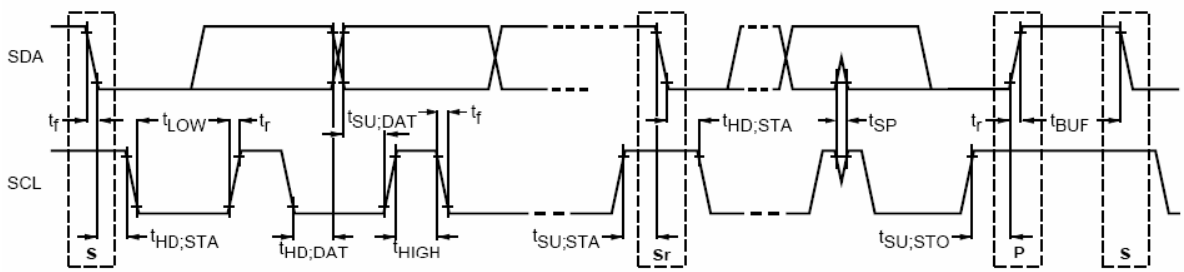
Logic Levels

NTS500 series power supply I2C Communication Bus will respond to logic levels as per below:

Logic High: 5.1V Nominal (Specs is 2.1V to 5.5V)**
Logic Low: 500mV nominal (Specs is 800mV max)**

** Note: Philips™ I2C adapter was used.

Timings



Parameter	Symbol	Standard-Mode Soecs		Actual		Unit
		Min	Max			
SCL Clock Frequency	f_{SCL}	0	100	100		kHz
Hold time (repeated) START condition	$t_{HD;STA}$	4.0	-	5.01		us
LOW period of SCL clock	t_{LOW}	4.7	-	5.5872		us
HIGH period of SCL clock	t_{HIGH}	4.0	-	4.2840		us
Setup time for repeated START condition	$t_{SU;STA}$	4.7	-	4.9172		us
Data hold time	$t_{HD;DAT}$	0	3.45	0.003376		us
Data setup time	$t_{SU;DAT}$	250	-	4728		ns
Rise time	t_r	-	1000	SCL = 767.359	SDA = 617.839	ns
Fall time	t_f	-	300	SCL = 152.103	SDA = 140.94	ns
Setup time for STOP condition	$t_{SU;STO}$	4.0	-	4.27		us
Bus free time between a STOP and START condition	t_{BUF}	4.7	-	3.33718msec***		us

*** Note Philips™ I2C adapter and bundled software (USB-to-I2C) was used

Device Addressing

The NTS500 series will respond to supported commands on the I2C bus that are addressed according to pins A2, A1 and A0 pins of CN403.

PMBus™ address is B, [logic combination of A2, A1 and A0].

FRU address is A, [logic combination of A2, A1 and A0].

Address pins are held HIGH by default via pull-up to 5V_I2C. Connect these pins to GND to set it logic LOW.

As an example, if the address pins were left unconnected, A2, A1 and A0 are logic High. Thus, addressing is as follows:

PMBus™ - B, [A2, A1, A0, 0] therefore, if left unconnected, B, [1,1,1,0] = BE (default PMBus Address)

FRU - A, [A2, A1, A0, 0] therefore, if left unconnected, A,[1,1,1,0] = AE (default FRU Address)

Important: The least significant bit of the address byte is always 0.

The i^2C address of the device is based on the slot the PSU is in. The address is defined as follows:

Bus	PSU Slot	Slot ID Bits			PMBus™ Address	EEPROM (FRU) Address
		A2	A1	A0*		
I2C _PSU1	1	0	0	0	B0	A0
I2C _PSU2	2	0	0	1	B2	A2
I2C _PSU3	3	0	1	0	B4	A4
I2C _PSU4	4	0	1	1	B6	A6
I2C _PSU5	5	1	0	0	B8	A8
I2C _PSU6	6	1	0	1	BA	AA
I2C _PSU7	7	1	1	0	BC	AC
I2C _PSU8	8	1	1	1	BE	AE

* Always “1” for NTS508/-CF/-M/-M-CF

Input Fusing

NTS500 series is equipped with an internal non user serviceable 10A High Rupturing Capacity (HRC) 250 Vac fuse to IEC 127 for fault protection in both the 'live' and 'neutral' lines input.

Over Voltage Protection (OVP)

The power supply latches off during output overvoltage with the AC line recycled to reset the latch.

NTS503

Parameter	Min	Nom	Max	Unit
V1 Output Overvoltage	14.4	/	16.2	V

NTS505

Parameter	Min	Nom	Max	Unit
V1 Output Overvoltage	28.8	/	32.4	V

NTS506

Parameter	Min	Nom	Max	Unit
V1 Output Overvoltage	21.6	/	24.3	V

NTS508

Parameter	Min	Nom	Max	Unit
V1 Output Overvoltage	57.6	/	64.8	V

Over Current Protection (OCP)

NTS500 series includes internal current limit circuitry to prevent damage in the event of overload or short circuit. In the event of overloads, the output voltage may deviate from the regulation band but recovery is automatic when the load is reduced to within specified limits. The current sensing circuit is set to 115% to 130% of full load current at 90% of nominal output voltage. If an overload occurs this circuit takes control of the feedback loop and forces the unit into constant current mode and Its output voltage is reduced to maintain safe power dissipation. If the overload is removed the power supply will immediately revert to constant voltage control and resume regulation at voltage setpoint.

NTS503

Parameter	Min	Nom	Max	Unit
V1 Output Overcurrent	47.9	/	54.2	A

NTS505

Parameter	Min	Nom	Max	Unit
V1 Output Overcurrent	23.9	/	27.1	A

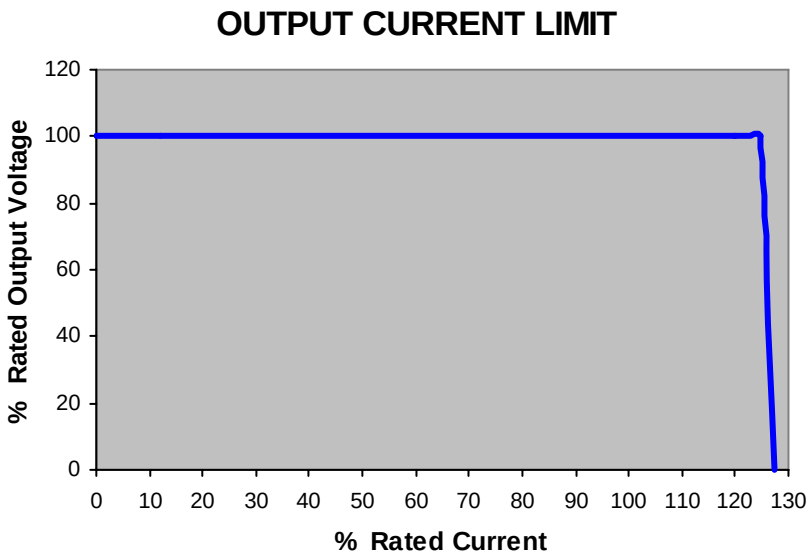
NTS506

Parameter	Min	Nom	Max	Unit
V1 Output Overcurrent	31.9	/	36.1	A

NTS508

Parameter	Min	Nom	Max	Unit
V1 Output Overcurrent	11.9	/	13.5	A

Typical Output Current Limit



Short Circuit Protection (SCP)

The power supply will withstand a continuous short circuit with no permanent damage. The power supply will automatically restart when the short circuit is removed. A short is defines as impedance less than 50 milliohms.

Over Temperature Protection (OTP)

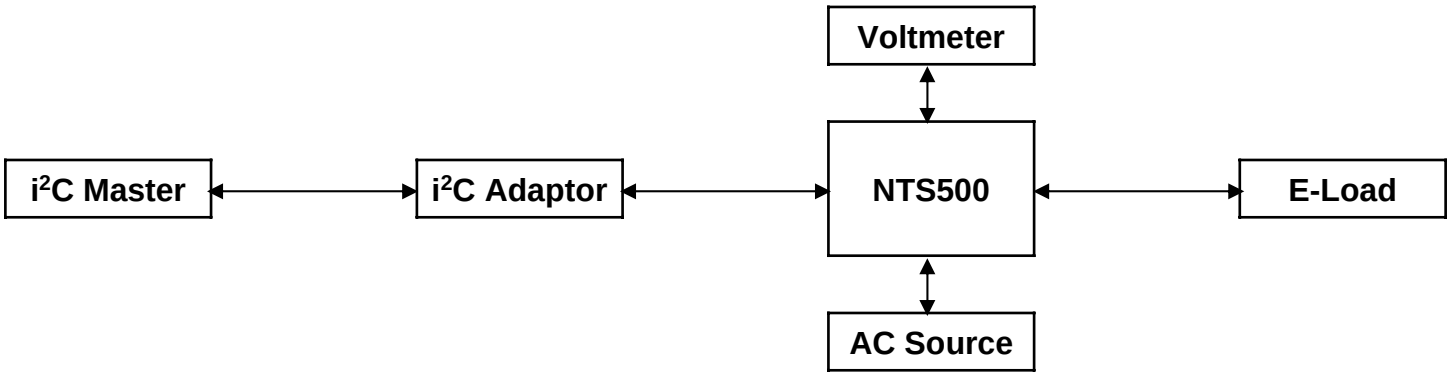
The power supply latches off during over-temperature condition either the primary or secondary and returns back to normal operation when the power supply is cooled down. The NTS500 might experience over-temperature conditions during a persistent overload on the output. Overload conditions can be caused by external faults. OTP might also be entered due to a loss of control of the environmental conditions e.g. an increase in the converter's ambient temperature due to a failing fan or external cooling system etc. During thermal shutdown, the 5 VSB and +12V Fan outputs will remain active.

The NTS500 is compliant with the industry standard PMBus™ protocol for monitoring and control of the power supply via the i²C interface port.

NTS500 Series PMBus™ General Instructions

Equipment Setup

The following is typical i²C™ communication setup:



PMBus™ Writing Instructions

When writing to any PMBus™ R/W registers, ALWAYS do the following:

Disable Write Protect (command 0x10) by writing any of the following accordingly:

Levels: 0x80 – Enable

0x00 – Disable

To save changes on the USER PMBus™ Table:

Use send byte command: 0x15 STORE_USER_ALL

To save changes on the DEFAULT PMBus™ Table:

Use send byte command: 0x11 STORE_DEFAULT_ALL

Wait for 5 seconds, turn-off the PSU, wait for another 5 seconds before turning it on.

NTS500 Series Support PMBus™ Command List

The NTS500 is compliant with the industry standard PMBus™ protocol for monitoring and control of the power supply via the i²C interface port.

NTS500 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value (HEX)				Access Type	Data Bytes	Data Format
		NTS503	NTS505	NTS506	NTS508			
01h	OPERATION	0x80	0x80	0x80	0x80	R/W	1	
02h	ON_OFF_CONFIG	0x14	0x14	0x14	0x14	R	1	
03h	CLEAR_FAULTS	-	-	-	-	S	0	
10h	WRITE_PROTECT	0x80	0x80	0x80	0x80	R/W	1	
11h	STORE_DEFAULT_ALL	-	-	-	-	S	0	
12h	RESTORE_DEFAULT_ALL	-	-	-	-	S	0	
15h	STORE_USER_ALL	-	-	-	-	S	0	
16h	RESTORE_USER_ALL	-	-	-	-	S	0	
19h	CAPABILITY	0x00	0x00	0x00	0x00	R	1	
20h	VOUT_MODE	0x40	0x40	0x40	0x40	R	1	
21h	VOUT_COMMAND	0x04B0	0x0960	0x0708	0x12C0	R/W	2	Direct
22h	VOUT_TRIM	0x0000	0x0000	0x0000	0x0000	R/W	2	Direct
23h	VOUT_CAL_OFFSET	0x0000	0x0000	0x0000	0x0000	R/W	2	Direct
24h	VOUT_MAX	0x04C8	0x0990	0x072C	0x1320	R	2	Direct
29h	VOUT_SCALE_LOOP	-	-	-	-	R	2	Direct
2Ah	VOUT_SCALE_MONITOR	-	-	-	-	R	2	Direct
30h	COEFFICIENTS	*See explanatory notes 1				P		
31h	POUT_MAX	0x01F4	0x01F4	0x01F4	0x01F4	R	2	Linear
35h	VIN_ON	0xF8A4	0xF8A4	0xF8A4	0xF8A4	R	2	Linear
36h	VIN_OFF	0xF896	0xF896	0xF896	0xF896	R	2	Linear
38h	IOUT_CAL_GAIN	0x100	0x100	0x100	0x100	R/W	2	Direct
39h	IOUT_CAL_OFFSET	0x0000	0x0000	0x0000	0x0000	R/W	2	Direct
40h	VOUT_OV_FAULT_LIMIT	0x05FA	0x0BF4	0x08F7	0x17E8	R/W	2	Direct
41h	VOUT_OV_FAULT_RESPONSE	0xC0	0xC0	0xC0	0xC0	R	1	
42h	VOUT_OV_WARN_LIMIT	0x051C	0x0A38	0x07AA	0x1470	R/W	2	Direct
43h	VOUT_UV_WARN_LIMIT	0x0438	0x0870	0x0654	0x10E0	R/W	2	Direct
44h	VOUT_UV_FAULT_LIMIT	0x03FC	0x07F8	0x05FA	0x0FF0	R/W	2	Direct
45h	VOUT_UV_FAULT_RESPONSE	0x87	0x87	0x87	0x87	R	1	
46h	IOUT_OC_FAULT_LIMIT	0x13F0	0x09F8	0x0D4B	0x04FC	R/W	2	Direct
47h	IOUT_OC_FAULT_RESPONSE	0xC0	0xC0	0xC0	0xC0	R	1	
4Ah	IOUT_OC_WARN_LIMIT	0x117F	0x08BF	0x0BA9	0x0460	R/W	2	Direct
4Fh	OT_FAULT_LIMIT	0x36B0	0x36B0	0x36B0	0x36B0	R/W	2	Direct
50h	OT_FAULT_RESPONSE	0xBF	0xBF	0xBF	0xBF	R	1	
51h	OT_WARN_LIMIT	0x2328	0x2328	0x2328	0x2328	R/W	2	Direct
55h	VIN_OV_FAULT_LIMIT	0xFA3A	0xFA3A	0xFA3A	0xFA3A	R	2	Linear
56h	VIN_OV_FAULT_RESPONSE	0xF2	0xF2	0xF2	0xF2	R	1	
57h	VIN_OV_WARN_LIMIT	0xFA1C	0xFA1C	0xFA1C	0xFA1C	R	2	Linear
58h	VIN_UV_WARN_LIMIT	0xF8A4	0xF8A4	0xF8A4	0xF8A4	R	2	Linear
59h	VIN_UV_FAULT_LIMIT	0xF896	0xF896	0xF896	0xF896	R	2	Linear
5Ah	VIN_UV_FAULT_RESPONSE	0xF8	0xF8	0xF8	0xF8	R	1	
5Eh	POWER_GOOD_ON	0x0498	0x0930	0x06E4	0x1194	R/W	2	Direct
5Fh	POWER_GOOD_OFF	0x0474	0x08E8	0x06AE	0x1140	R/W	2	Direct

Command Code	Command Name	Default Value (HEX)				Access Type	Data Bytes	Data Format
		NTS503	NTS505	NTS506	NTS58			
60h	TON_DELAY	0x0000	0x0000	0x0000	0x0000	R/W	2	Direct
61h	TON_RISE	0x12C0	0x12C0	0x12C0	0x12C0	R/W	2	Direct
64h	TOFF_DELAY	0x09C4	0x09C4	0x09C4	0x09C4	R/W	2	Direct
78h	STATUS_BYTE	-	-	-	-	R	1	
79h	STATUS_WORD	-	-	-	-	R	2	
7Ah	STATUS_VOUT	-	-	-	-	R	1	
7Bh	STATUS_IOUT	-	-	-	-	R	1	
7Ch	STATUS_INPUT	-	-	-	-	R	1	
7Dh	STATUS_TEMPERATURE	-	-	-	-	R	1	
80h	STATUS_MFR_SPECIFIC	-	-	-	-	R	1	
88h	READ_VIN	-	-	-	-	R	2	Linear
89h	READ_IIN	-	-	-	-	R	2	Linear
8Ah	READ_VCAP	-	-	-	-	R	2	Linear
8Bh	READ_VOUT	-	-	-	-	R	2	Direct
8Ch	READ_IOUT	-	-	-	-	R	2	Direct
8Dh	READ_TEMPERATURE_1	-	-	-	-	R	2	Direct
8Eh	READ_TEMPERATURE_2	-	-	-	-	R	2	Direct
96h	READ_POUT					R	2	Linear
97h	READ_PIN	-	-	-	-	R	2	Linear
98h	PMBUS_REVISION	0x11	0x11	0x11	0x11	R	1	
99h	MFR_ID	0x0341 494C	0x0341 494C	0x0341 494C	0x0341 494C	BR	3	
9Ch	MFR_LOCATION	0x0343 4156	0x0343 4156	0x0343 4156	0x0343 4156	BR	3	
A0h	MFR_VIN_MIN	0x2328	0x2328	0x2328	0x2328	R	2	Direct
A1h	MFR_VIN_MAX	0x6720	0x6720	0x6720	0x6720	R	2	Direct
A2h	MFR_IIN_MAX	0x02C6	0x02C6	0x02C6	0x02C6	R	2	Direct
A4h	MFR_VOUT_MIN	0x0498	0x0930	0x072C	0x1260	R	2	Direct
A5h	MFR_VOUT_MAX	0x04C8	0x0990	0x06E4	0x1320	R	2	Direct
A6h	MFR_IOUT_MAX	0x1047	0x0823	0x0ADA	0x0412	R	2	Direct
A7h	MFR_POUT_MAX	0x01F4	0x01F4	0x01F4	0x01F4	R	2	Linear
A8h	MFR_TAMBIENT_MAX	0x1388	0x1388	0x1388	0x1388	R	2	Direct
A9h	MFR_TAMBIENT_MIN	0x0000	0x0000	0x0000	0x0000	R	2	Direct
AAh	MFR_EFFICIENCY_LL	0x0EA500 3F185300 FFFFFFFF FFFFFFFF	0x0EA500 3F185300 FFFFFFFF FFFFFFFF	0x0EA500 3F185300 FFFFFFFF FFFFFFFF	0x0EA500 3F185300 FFFFFFFF FFFFFFFF	BR	14	
ABh	MFR_EFFICIENCY_HL	0x0EAF00 3F185300 FFFFFFFF FFFFFFFF	0x0EAF00 3F185300 FFFFFFFF FFFFFFFF	0x0EAF00 3F185300 FFFFFFFF FFFFFFFF	0x0EAF00 3F185300 FFFFFFFF FFFFFFFF	BR	14	
CFh	MFR_MODEL_CODE	0x074E 54532D 353033	0x074E 54532D 353035	0x074E 54532D 353036	0x074E 54532D 353038	BR	7	
D0h	DEVICE_CODE	-	-	-	-	BR		
D1h	ISP_KEY	-	-	-	-	BW		
D2h	ISP_CMD	-	-	-	-	R/W	1	

Command Code	Command Name	Default Value (HEX)				Access Type	Data Bytes	Data Format
		NTS503	NTS508	NTS505	NTS506			
D3h	FLASH_ADDRESS	-	-	-	-	BW/BR		
D4h	FLASH_DATA	-	-	-	-	BW/BR		
D5h	FW_VERSION	-	-	-	-	BR		
EEh	PRI_CODE_REV	Must track Pri Firmware Rev				BR	3	
EFh	SEC_CODE_REV	Must track Sec Firmware Rev				BR	3	
F0h	VO_CALIB	-	-	-	-	R/W	2	
F1h	ISHARE_CALIB	-	-	-	-	R/W	2	
F2h	VI_II60_IO_CALIB	-	-	-	-	R/W	2	
F3h	PI_CALIB_AC	-	-	-	-	R/W	2	
F4h	PI_CALIB_DC	-	-	-	-	R/W	2	
F7h	RECOVER_CALIB	*See explanatory note 2				P		
F8h	SAVE_CALIB_DATA	-	-	-	-	S	2	

Explanatory Notes:

Note 1 - 0x30 Coefficient command structure:

1	7	1	1	8	1	8	1	8	1	8	1
S	SLAVE ADDRESS	W	A	COEFFICIENTS COMMAND CODE	A	BYTE COUNT = 2	A	PARAMETER CODE LOW BYTE	A	PARAMETER CODE HIGH BYTE	A

1	7	1	1	8	1	8	1	8	1
Sr	SLAVE ADDRESS	R	A	BYTE COUNT = 5	A	m: Low Byte	A	m: High Byte	A

8	1	8	1	8	1	8	1	1
b: Low Byte	A	b: High Byte	A	R: One Byte	A	PEC	NA	P

If the product does not support PEC, the PEC byte on the Coefficient command is not included.

Note 2 - 0xF7 RECOVER_CALIB Command definition table:

Index	Parameter	Read Length	Access Structure
00h	VREG_CAL_GAIN	4	Command Format: S, BE, W, F7, 01, Xx, S, BE, R, --, --, --, --, P Where: Xx – desired calibration data index Returned data are as follows (LSB to MSB): - Number of bytes to be read - Calibration data Index - Calibration data LSB - Calibration data MSB
01h	VOUT_CAL_GAIN	4	
02h	IMON_CAL_GAIN_DIV_3_var_1	4	
03h	IMON_CAL_OFFSET_var_1	4	
04h	IMON_CAL_GAIN_DIV_3_var_2	4	
05h	IMON_CAL_OFFSET_var_2	4	
06h	IMON_CAL_GAIN_DIV_3_var_3	4	
07h	IMON_CAL_OFFSET_var_3	4	
08h	IMON_CAL_GAIN_DIV_3_var_4	4	
09h	IMON_CAL_OFFSET_var_4	4	
0Ah	IOUT_CAL_GAIN_DIV_2_var	4	
0Bh	IOUT_CAL_OFFSET_var	4	
0Ch	VIN_CAL_GAIN_AC_var	4	
0Dh	VIN_CAL_OFFSET_AC_var	4	
0Eh	VIN_CAL_GAIN_DC_var	4	

Note 2 - 0xF7 RECOVER_CALIB Command definition table continue:

Index	Parameter	Read Length	Access Structure
0Fh	VIN_CAL_OFFSET_DC_var	4	WRITE CALIB DATA
10h	IIN_CAL_60GAIN_var	4	Command Format: S, BE, W, F7, 03, Xx, Yy, Zz, P Where: Xx – Calibration data Index Yy – Calibration data LSB Zz – Calibration data MSB
11h	IIN_CAL_60OFFSET_var	4	
12h	IIN_CAL_440GAIN_var	4	
13h	IIN_CAL_440OFFSET_var	4	
14h	PIN_CAL_GGAIN_AC_var	4	
15h	PIN_CAL_GOFFSET_AC_var	4	
16h	PIN_CAL_OGAIN_AC_var	4	
17h	PIN_CAL_OOFFSET_AC_var	4	
18h	PIN_CAL_GGAIN_MULTIPLIER_AC_var	4	
19h	PIN_CAL_OGAIN_MULTIPLIER_AC_var	4	
1Ah	PIN_CAL_GAIN_MULTIPLIER_AC_var	4	To save, use 0xF8 SAVE_CALIB Command
1Bh	PIN_CAL_GGAIN_DC_var	4	Command Format: S, BE, W, F8, AA, AA, P
1Ch	PIN_CAL_GOFFSET_DC_var	4	
1Dh	PIN_CAL_OGAIN_DC_var	4	
1Eh	PIN_CAL_OOFFSET_DC_var	4	
1Fh	PIN_CAL_GGAIN_MULTIPLIER_DC_var	4	
20h	PIN_CAL_OGAIN_MULTIPLIER_DC_var	4	
21h	PIN_CAL_GAIN_MULTIPLIER_DC_var	4	

PMBus™ R//W Commands Permissible Range of Values:

Command Code	Command Name	Permissible Values
21h	VOUT_COMMAND	Resulting regulation must be within 98% to 102% of nominal Vout Reg
22h	VOUT_TRIM	
23h	VOUT_CAL_OFFSET	
40h	VOUT_OV_FAULT_LIMIT	120% to 135% of nominal Vout Reg
42h	VOUT_OV_WARN_LIMIT	>102% of nominal Vout Reg to <Set OVP fault
43h	VOUT_UV_WARN_LIMIT	>Set UV Fault to <98% of nominal Vout Reg
44h	VOUT_UV_FAULT_LIMIT	84% to 86% of nominal Vout Reg
46h	IOUT_OC_FAULT_LIMIT	115% to 130% of rated Full Load
4Ah	IOUT_OC_WARN_LIMIT	>100% of rated Full Load to <Set OCP Fault
4Fh	OT_FAULT_LIMIT	100degC to 150degC
51h	OT_WARN_LIMIT	50degC to <Set OTP Fault
5Eh	POWER_GOOD_ON	>Set UV Fault to <98% of nominal Vout Reg
5Fh	POWER_GOOD_OFF	>Set UV Fault to <95% of nominal Vout Reg
60h	TON_DELAY	Max not to exceed 2sec of turn on time
61h	TON_RISE	40msec to 50msec
64h	TOFF_DELAY	0 to 25msec

For more information regarding PMBus™ commands/command usage, please refer to the following documents:

- I^2C bus specification, Version 2.1, January 2000. Philips Semiconductor

- PMBus™ Specification Revision 1.1, February 2007. www.powersig.org

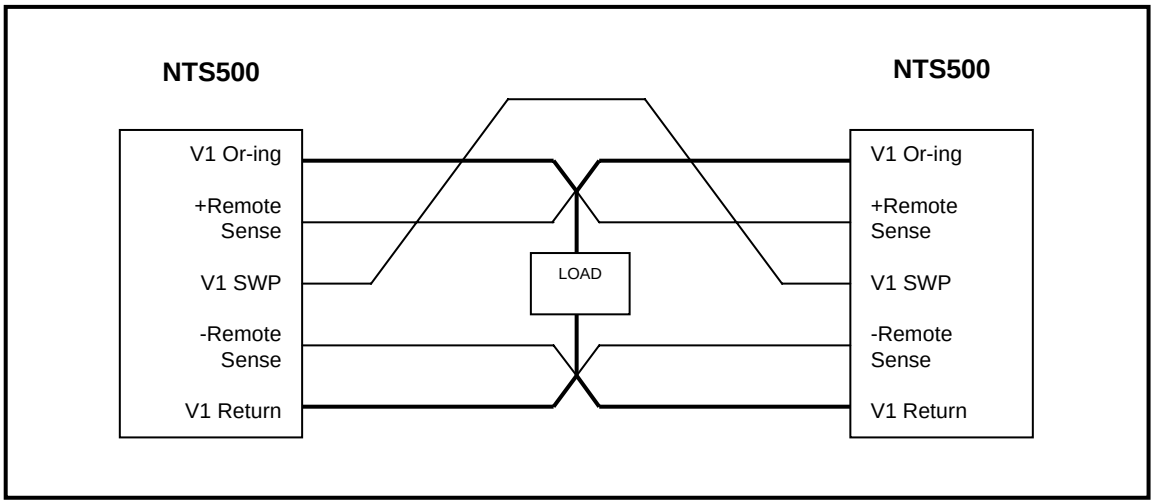
Current Sharing

The NTS500 series' main output V1 is equipped with current sharing capability. This will allow up to 8* power supplies to be connected in parallel for higher power application. Current share accuracy is typically 10% of full load. SWP Node voltage at full load is to be 5.0 Volts and 1.2 Volts at 20% of maximum current. Pull in voltage range shall be a maximum difference between power supplies of 5%.

*Note: Communication via PMBusTM is available only for upto 8 PSU's for NTS503/NTS505 and upto 4 PSU's for NTS508 due to addressing restrictions. See section – Device Addressing.

Redundancy/Fault Tolerance

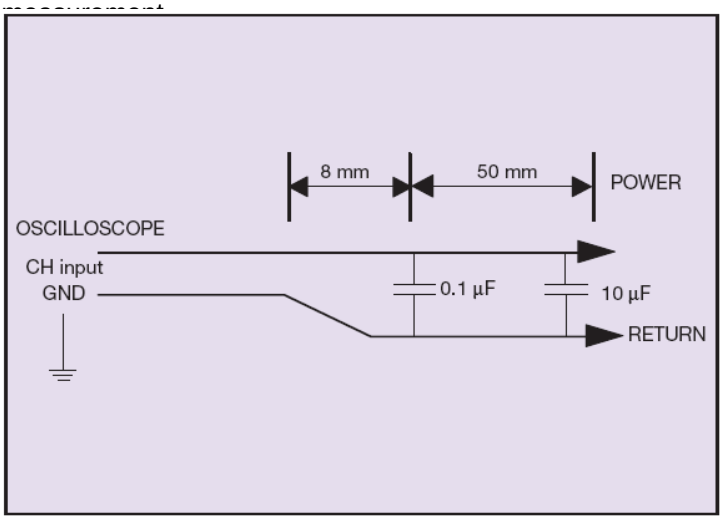
The NTS500 series power supplies can be connected in the following to provide redundancy/fault tolerance operation:



This will allow up to N* power supplies to be connected in an N+1 redundant load. Any failure of one power supply in parallel as well as hot swapping shall not cause more than a 3% or 150mV (which ever is greater) change in any output. Current share accuracy is typically 10% of full load. The Failure of one or more supplies will not cause the remaining supplies to violate any of the input or output specifications noted in this specification including all status signals

Output Ripple and Noise Measurement

The setup outlined in the diagram below has been used for output voltage ripple and noise measurements on the NTS500 Series. When measuring output ripple and noise, a scope jack in parallel with a 0.1uF ceramic chip capacitor, and a 10 uF aluminum electrolytic capacitor should be used. Oscilloscope should be set to 20 MHz bandwidth for this measurement.



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