

ARTESYN DS2000SPE-3 SERIES

2000 Watts Distributed Power System



PRODUCT DESCRIPTION

Advanced Energy's Artesyn DS2000SPE-3 is an ultra-high density power supply providing 50W per cubic in. The 2000 watts DS2000SPE power supply is housed in 1U high rack-mounting enclosures measuring just 3.4 x 7.7 in (86.3 x 196.5 mm). This form factor is significantly shorter than that of similarly rated earlier-generation power supplies — freeing up valuable system space and is achieved by use of the latest power switching technology and high density component packaging techniques.

SPECIAL FEATURES

- 2000W output power at high line
- 1U power supply
- High power and short form factor
- High density design: 50W/in³
- Active power factor correction
- EN61000-3-2 harmonic compliance
- Inrush current control
- 80PLUS® Platinum efficiency
- N+N, N+1 redundant
- Hot-pluggable
- Active current sharing
- Two-year warranty
- PMBus™ compliant

SAFETY

- UL/cUL62368
- TUV+CB Report EN62368
- EN62368
- CE Mark
- UKCA Mark

TYPICAL APPLICATIONS

- Industrial

AT A GLANCE

Total Power

2000 Watts

Input Voltage

90 to 140 Vac
180 to 264 Vac

of Outputs

Main and Standby



MODEL NUMBERS

Standard	Output Voltage	Minimum Load	Maximum Load	Stand-By Supply	Air Flow Direction
DS2000SPE-3	12.2Vdc	0A	163.9A	12Vdc@3.5A	Forward (DC Connector to Handle)

Options

None

ELECTRICAL SPECIFICATIONS

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	Models	Symbol	Min	Typ	Max	Unit
Input Voltage AC continuous operation	All models	$V_{IN,AC}$ $V_{IN,AC}$	90	-	140	Vac
			180	-	264	Vac
Maximum Output Power (Main + Standby) $V_{IN,AC} \leq 140Vac$ $V_{IN,AC} \geq 180Vac$	All models	$P_{O,max}$	-	-	1000	W
	All models	$P_{O,max}$	-	-	2000	W
Isolation Voltage Input to outputs Input to safety ground	All models		-	-	3000	Vac
	All models		-	-	2000	Vac
Ambient Operating Temperature ¹	DS2000SPE-3	T_A	0	-	50	°C
Storage Temperature	All models	T_{STG}	-40	-	70	°C
Humidity (non-condensing) Operating Non-operating	All models		5	-	95	%
	All models		5	-	95	%
Altitude ² Operating Non-operating	All models		-	-	16400	Feet
	All models		-	-	50000	Feet
MTBF ³	All models		900	-	-	KHours
Operating Life ⁴	All models		5	-	-	Years

Note 1 - The power supply can be allowable up to 60°C without damage.

Note 2 - It is tested at 35°C ambient temperature and 85% $I_{O,max}$.

Note 3 - It is calculated under 50°C ambient temperature and 80% $I_{O,max}$, 180Vac/264Vac, telcordia issue 3 method 1, case 3.

Note 4 - It is calculated under 40°C ambient temperature and 80% $I_{O,max}$.

ELECTRICAL SPECIFICATIONS

Input Specifications

Table 2. Input Specifications						
Parameter	Condition	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, AC	All	$V_{IN,AC}$	90	115/230	264	Vac
Input AC Frequency	All	$f_{IN,AC}$	47	50/60	63	Hz
Maximum Input Current ($I_O = I_{O,max}$, $I_{SB} = I_{SB,max}$)	$V_{IN,AC} = 90Vac$ $V_{IN,AC} = 180Vac$	$I_{IN,max}$	- -	- -	12.8 12.8	A A
Standby Input Current ($V_O = Off$, $I_{SB} = 0A$)	$V_{IN,AC} = 90Vac$ $V_{IN,AC} = 180Vac$	$I_{IN,Standby}$	- -	- -	150 180	mA mA
Standby Input Power ($V_O = Off$, $I_{SB} = 0A$)	$V_{IN,AC} = 90Vac$ $V_{IN,AC} = 180Vac$	$P_{IN,Standby}$	- -	- -	4 4	W W
No Load Input Current ($V_O = On$, $I_O = 0A$, $I_{SB} = 0A$)	$V_{IN,AC} = 90Vac$ $V_{IN,AC} = 180Vac$	$I_{IN,no-load}$	- -	- -	180 200	mA mA
Harmonic Line Currents ¹	All	THD	Per EN61000-3-2			
Power Factor	$V_{IN,AC} = 115/230Vac$ 20% load and above	PF	0.90	-	-	
Startup Surge Current (Inrush) @ 25°C	$V_{IN,AC} = 264Vac$	$I_{IN,surge}$	-	-	50	A
Input Fuse	Internal, 5x20mm, Quick Acting 16A, 420Vdc		-	-	16	A
Leakage Current	$V_{IN,AC} = 264Vac$ $f_{IN,AC} = 50/60Hz$		-	-	1	mA
Operating Efficiency ² @ 25°C	$V_{IN,AC} = 230Vac$ $I_O = 10\%I_{O,max}$ $I_O = 20\%I_{O,max}$ $I_O = 50\%I_{O,max}$ $I_O = 100\%I_{O,max}$	η	80 90 94 91	- - - -	- - - -	% % % %
System Stability	Phase Margin Gain Margin		45 -	- -6	- -	\emptyset dB

Note 1 - Harmonic line currents meet 10% THD from 50% to 100% load.

Note 2 - Power supply is certified for 80PLUS Platinum efficiency level at 230Vac. The loading conditions are defined according to CSCI criteria.

ELECTRICAL SPECIFICATIONS

Output Specifications

Table 3. Output Specifications						
Parameter	Condition	Symbol	Min	Typ	Max	Unit
Factory Set Voltage	All	V_O	-0.2	-	+0.2	$\%V_O$
		V_{SB}	-0.4	-	+0.4	$\%V_{SB}$
Output Regulation	Inclusive of set-point, temperature change, warm-up drift and dynamic load	V_O	11.40	12.20	12.90	Vdc
		V_{SB}	11.40	12.00	12.60	Vdc
Output Ripple, pk-pk	Measure with a 0.1 μ F ceramic capacitor in parallel with a 10 μ F tantalum capacitor, 10 to 20MHz bandwidth	V_O	-	-	180	mV _{PK-PK}
		V_{SB}	-	-	120	mV _{PK-PK}
Output Current ¹	$V_{IN,AC} \leq 140V_{ac}$ $V_{IN,AC} \geq 180V_{ac}$	I_O	5.0	-	82	A
		I_O	5.0	-	163.9	A
Main Output Current Share Accuracy	10% to 100% $I_{O,max}$	$\%I_O$	-	-	5	$\%I_{O,max}$
Minimum Load for Current Sharing			10	-	-	$\%I_{O,max}$
Load Capacitance	Start up	C_O	4900	-	38000	μ F
		C_{SB}	1	-	4700	μ F
Main Output Dynamic Response Peak Deviation	50% load change, slew rate = 0.5A/ μ S	V_O	-	-	5	$\pm\%V_O$
Main Output Long Term Stability Max change over 24 hours	After thermal equilibrium (30mins) $V_{IN,AC} = 100 / 200V_{ac}$	V_O	-	-	0.5	$\pm\%V_O$

Note 1 - Minimum current for transient load response testing only. Unit is designed to operate and be within output regulation range at zero load.

ELECTRICAL SPECIFICATIONS

System Timing Specifications

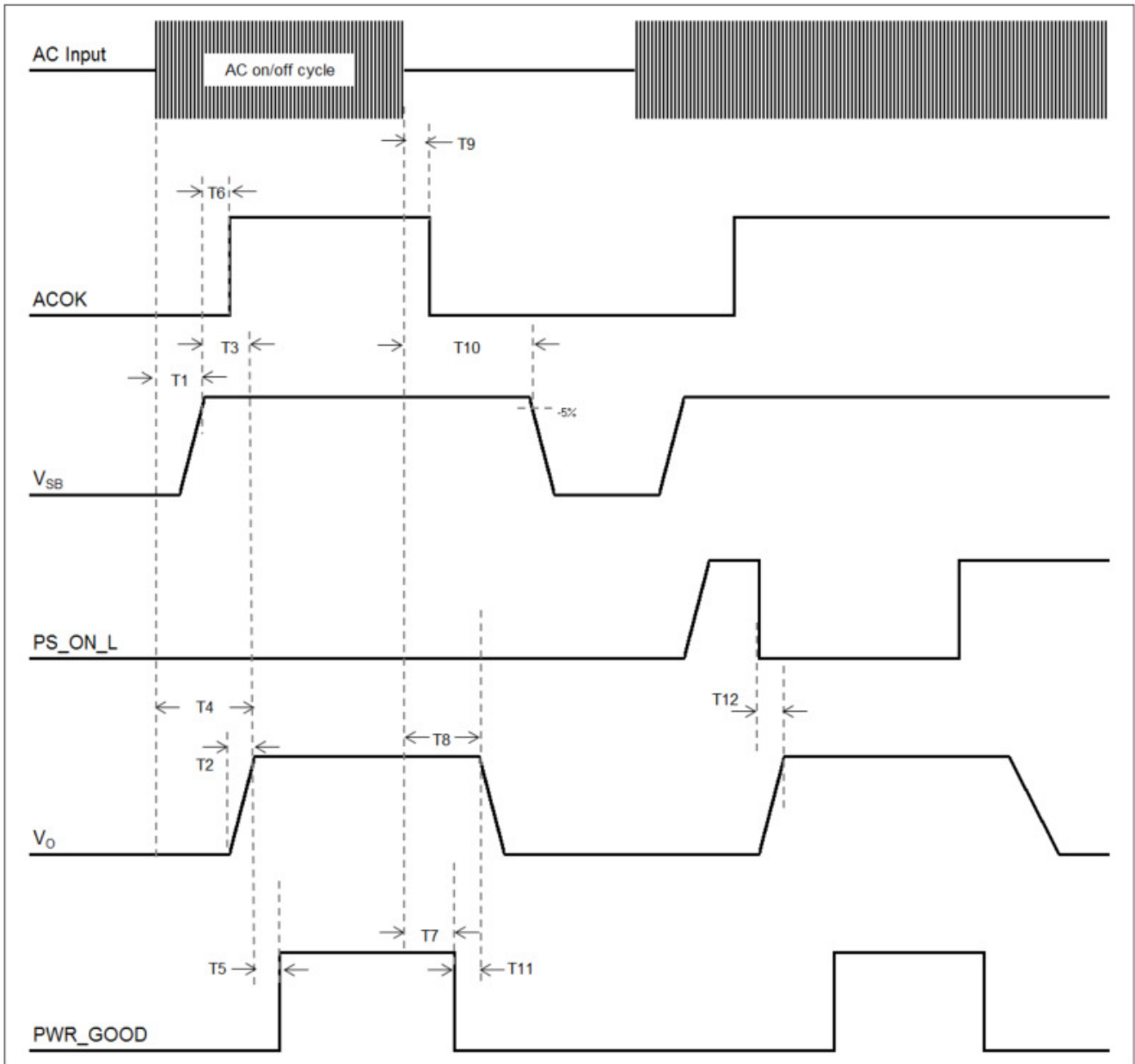
Table 4. System Timing Specifications					
Label	Parameter	Min	Typ	Max	Unit
T1 ¹	Delay from AC being applied to V _{SB} being within regulation.	20	-	2000	mSec
T2	Output voltage rise time from 10% to 90% of the main output.	0	-	100	mSec
T3	Delay from Standby output to main output voltage being within regulation.	-	-	300	mSec
T4	Delay from AC being applied to main output voltages being within regulation.	-	-	2300	mSec
T5	Delay from output voltages within regulation limits to Pwr_Good asserted.	100	-	1000	mSec
T6	Delay from standby output to ACOK assertion.	-	-	20	mSec
T7	Delay from loss of AC to de-assertion of Pwr_Good.	10	-	-	mSec
T8	Delay from loss of AC to main output being within regulation.	11	-	-	mSec
T9	Delay from loss of AC to de-assertion of ACOK.	-	-	8	mSec
T10	Delay from loss of AC to standby output being within regulation.	150 ²	-	-	mSec
T11	Delay from deassertion of Pwr_Good to output voltages falling out of regulation.	1	-	-	mSec
T12	Delay from PS_ON_L assertion to output voltages being within regulation.	-	-	350	mSec

Note 1 - T1 can assert earlier than the standby output.

Note 2 - T10 is measured with standby output loaded at 1A.

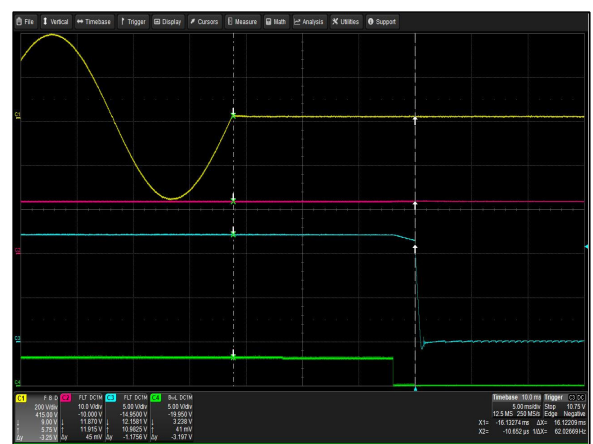
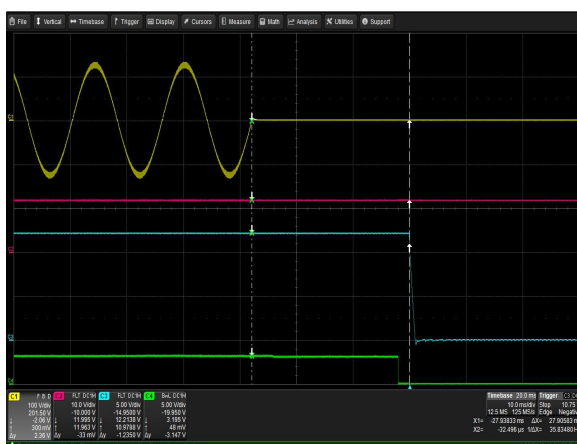
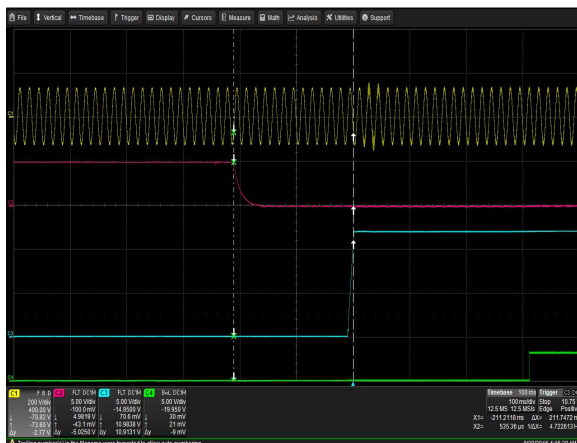
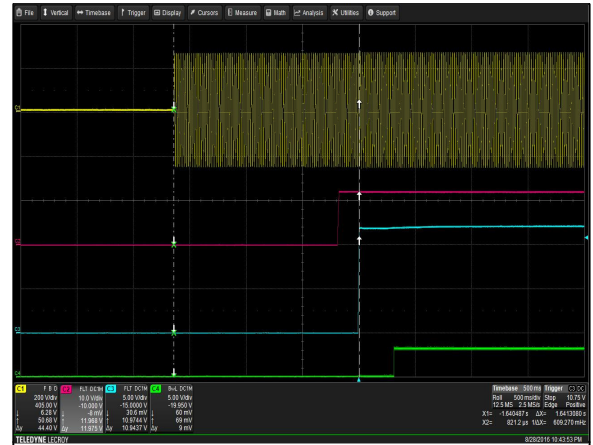
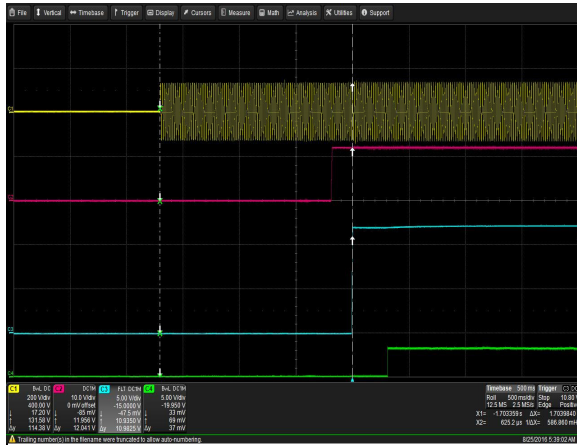
ELECTRICAL SPECIFICATIONS

System Timing Diagram



ELECTRICAL SPECIFICATIONS

DS2000SPE-3 Performance Curves



ELECTRICAL SPECIFICATIONS

DS2000SPE-3 Performance Curves



Figure 7: DS2000SPE-3 Output Voltage Startup Characteristic
 Vin = 90Vac Load: I_O = 78.52A I_{SB} = 3.5A
 Ch 1: V_O Ch 2: PWOK



Figure 8: DS2000SPE-3 Ripple and Noise Measurement
 Vin = 180Vac Load: I_O = 160.5A I_{SB} = 3.5A
 Ch 1: V_O Ch 2: PWOK



Figure 9: DS2000SPE-3 Turn Off Characteristic via PS_ON_L
 Load: I_O = 78.52A I_{SB} = 3.5A
 Ch 1: PS_ON_L Ch 2: V_O Ch 3: PWOK

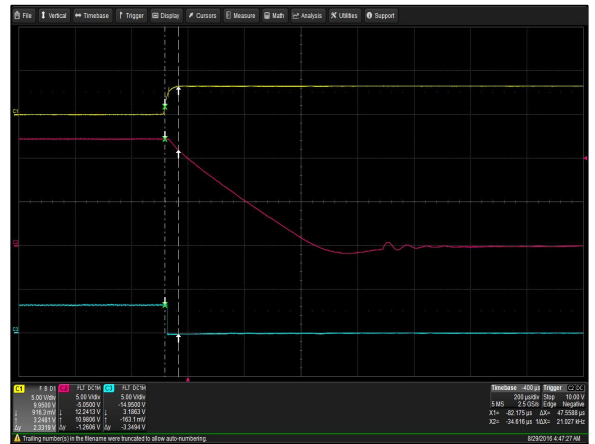


Figure 10: DS2000SPE-3 Turn Off Characteristic via PS_KILL_L
 Load: I_O = 160.5A I_{SB} = 3.5A
 Ch 1: PS_KILL_L Ch 2: V_O Ch 3: PWOK

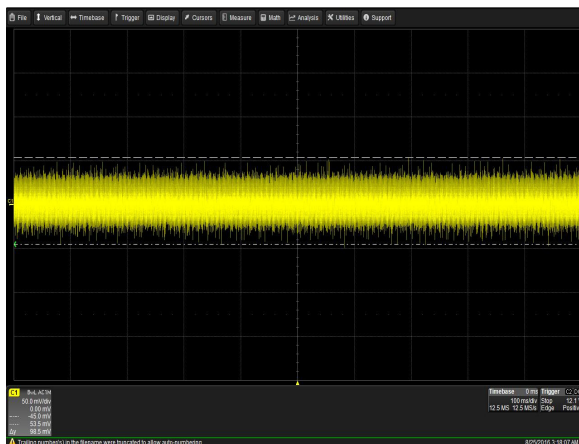


Figure 11: DS2000SPE-3 Ripple and Noise Measurement
 Vin = 115Vac Load: I_O = 78.52A I_{SB} = 3.5A
 Ch 1: V_O

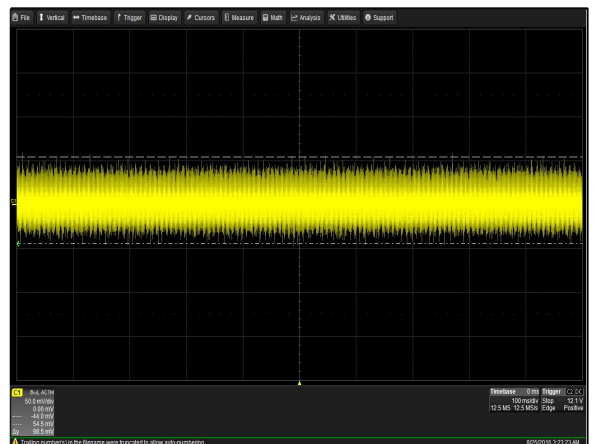


Figure 12: DS2000SPE-3 Ripple and Noise Measurement
 Vin = 230Vac Load: I_O = 160.5A I_{SB} = 3.5A
 Ch 1: V_O

ELECTRICAL SPECIFICATIONS

DS2000SPE-3 Performance Curves

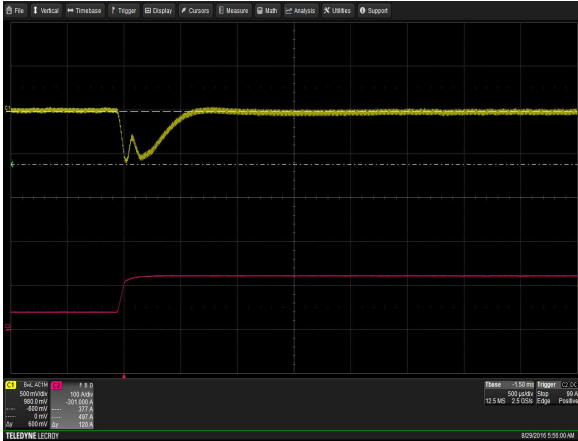


Figure 13: DS2000SPE-3 Transient Response - V_O Deviation
 25% to 75% load change 0.5A/uS slew rate $V_{in} = 230V_{ac}$
 Ch 1: V_O Ch 2: I_O

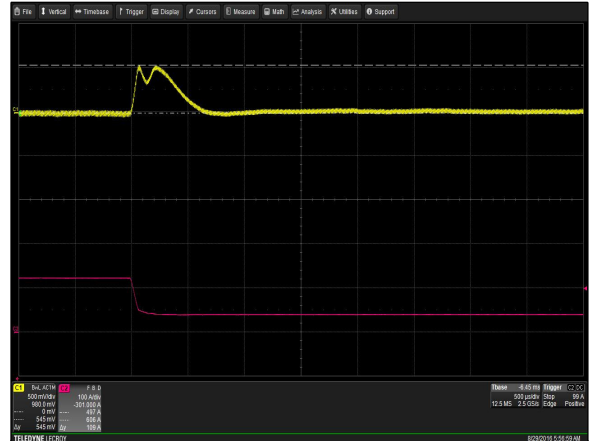


Figure 14: DS2000SPE-3 Transient Response - V_O Deviation
 75% to 25% load change 0.5A/uS slew rate $V_{in} = 230V_{ac}$
 Ch 1: V_O Ch 2: I_O

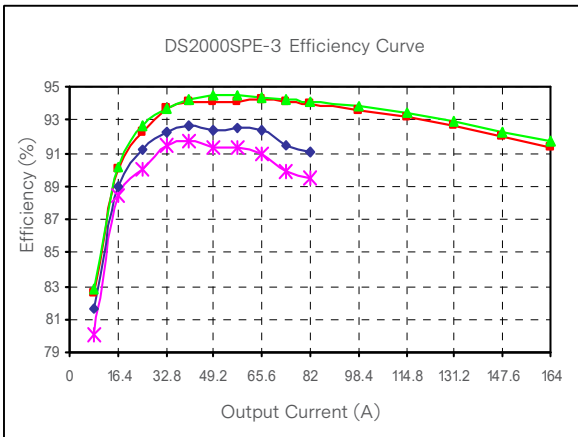


Figure 15: DS2000SPE-3 Efficiency Curve @ 25°C
 Loading: $I_{o_main} = 10\%I_{o_max}$ increment to 163.93A

ELECTRICAL SPECIFICATIONS

Protection Function Specifications

Input Fuse

DS2000SPE-3 series power supply is equipped with an internal non user serviceable 16A Fast Acting 420Vac fuse to IEC 127 for fault protection on L line input.

Over Voltage / Under Voltage Protection (OVP / UVP)

The power supply provides latch mode over and under voltage protection as defined by the output under voltage and output over voltage parameters for each output.

OVP

Parameter	Min	Nom	Max	Unit
V _O Output Overvoltage	13.5	/	14.5	V
V _{SB} Output Overvoltage	13.5	/	15.0	V

UVP

Parameter	Min	Nom	Max	Unit
V _O Output Overvoltage	10.0	/	10.5	V
V _{SB} Output Overvoltage	10.0	/	10.5	V

Over Temperature Protection (OTP)

The power supply is internally protected against over temperature conditions. When any of the sensing circuits have reached the OTP limit, all outputs, except standby, shut down and remain off until the over-temperature condition no longer exist. Upon reaching the temperature recovery point, all outputs auto-recover.

Any OTP fault is reported in the PMBus status flag, without discriminating which OTP sensing circuit was triggered.

ELECTRICAL SPECIFICATIONS

Over Current Protection (OCP)

DS2000SPE-3 series power supply includes internal current limit circuitry to prevent damage in the event of overload or short circuit. The current limiting shall be of the latched type for the +12.2Vdc and hiccup type for the standby output. A fault in the main output does not cause the standby output to shut down.

The standby has an OCP limit from 110% to 150% and auto-retry when the overload is removed. A fault in the standby output shuts down other outputs and auto-recovers when the overload on the standby is removed.

Parameter	Min	Nom	Max	Unit
V _O Output Overcurrent Protection	107	/	130	%I _{O,max}
V _{SB} Output Overcurrent Protection	110	/	150	%I _{SB,max}

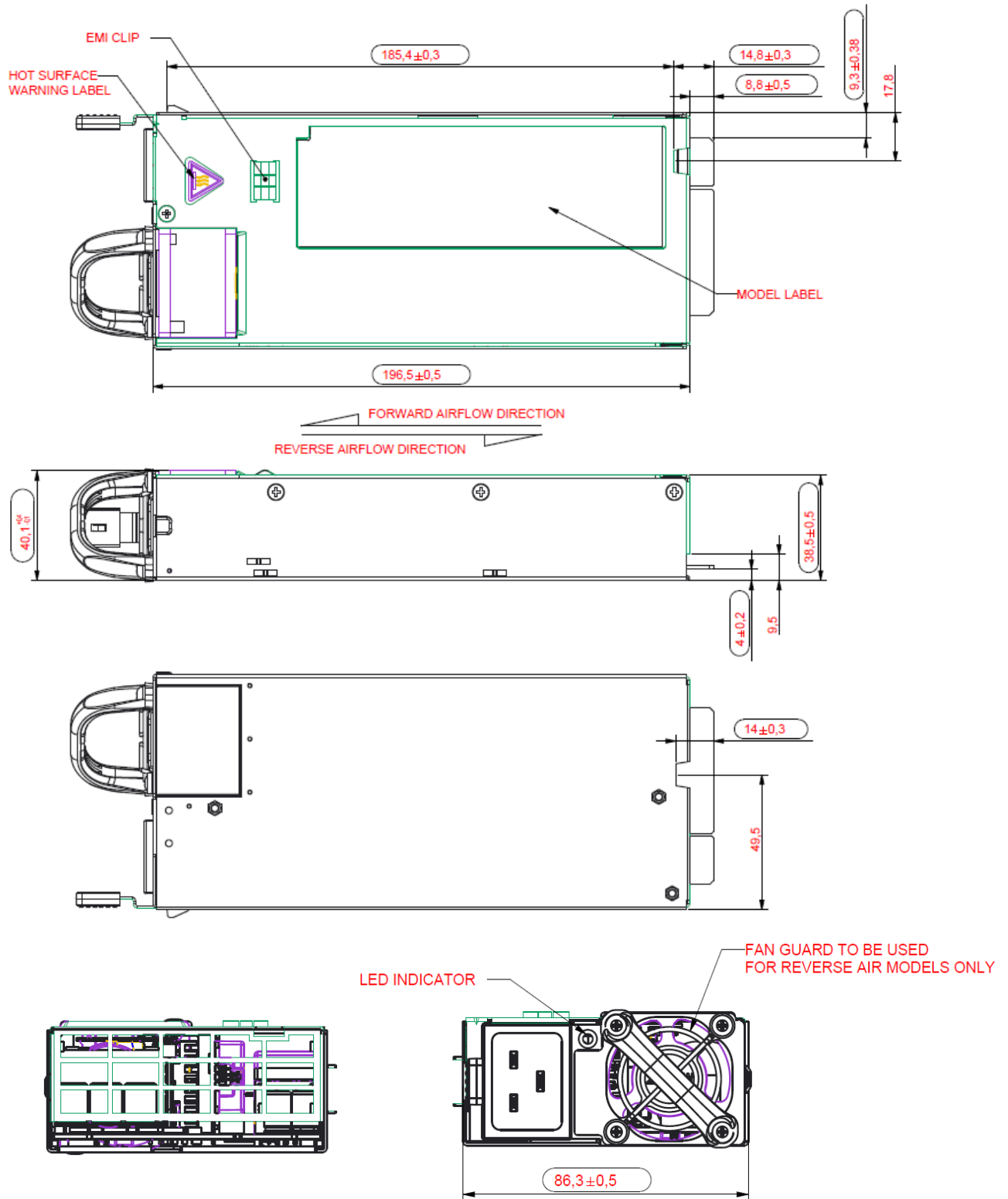
Short Circuit Protection (SCP)

The DS2000SPE-3 series power supply protects against a short circuit, which is defined as an impedance of 0.06ohm or less, applied to any output during start-up or while running will not cause any damage to the power supply.

When the standby output is shorted, the output goes into “hiccup mode”. When the standby output attempts to restart, the maximum peak current from the standby output is less than 10A peak. The maximum average current, taking into account the “hiccup” duty cycle, does not exceed the rated output current of the standby.

MECHANICAL SPECIFICATIONS

Mechanical Outlines (unit:mm)



MECHANICAL SPECIFICATIONS

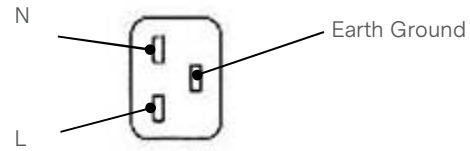
Connector Definitions

AC Input Connector

Pin 1 – Line

Pin 2 – Neutral

Pin 3 – Earth Ground



Output Connector - Power Blades

P1-P8 – Main Output (V_O)

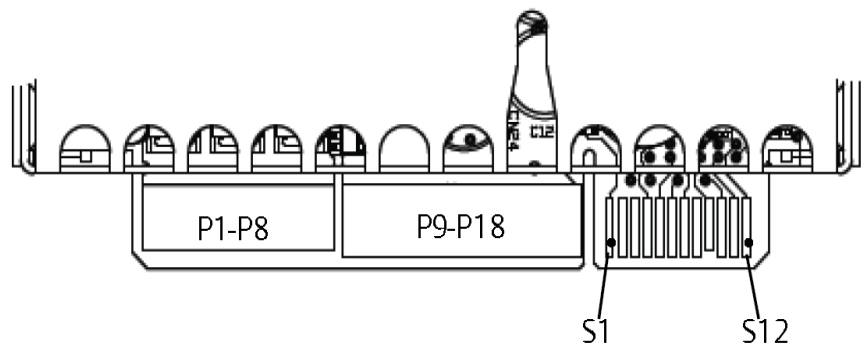
P9-P18 – Main Output Return

P19-P20 – Standby Output (V_{SB})

P21-P28 – Main Output Return

P29-P36 – Main Output (V_O)

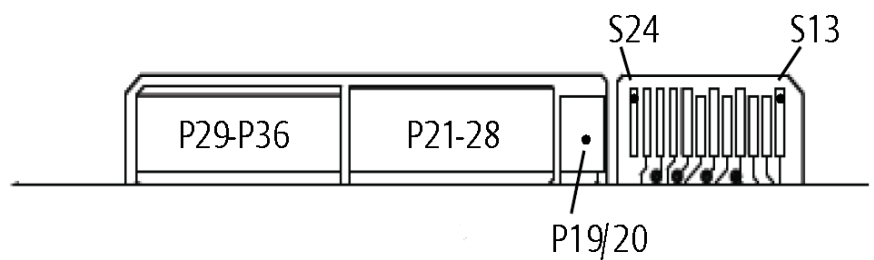
Power Supply Output Card Edge (Top Side)



Output Connector - Control Signals

- S1 – PS_PRESENT
- S2 – A1
- S3 – A0
- S4 – PWR_GOOD (PWOK)
- S5 – ACOK (AC Input Present)
- S6 – RETURN
- S7 – I_SHARE
- S8 – RESERVED
- S9 – PS_INTERRUPT_L / ALERT
- S10 – RETURN
- S11&S12 – RESERVED
- S13 – PS_ON_L
- S14 – PS_KILL_L
- S15 – RESERVED
- S16 – RETURN
- S17 – SDA
- S18 – RETURN
- S19 – SCL
- S20 – RETURN
- S21 – REMOTE SENSE-
- S22 – RETURN
- S23 – REMOTE SENSE+
- S24 – A2

Power Supply Output Card Edge (Bottom Side)



MECHANICAL SPECIFICATIONS

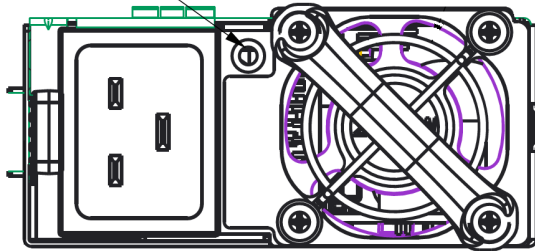
Power / Signal Mating Connectors and Pin Types

Table 5. Mating Connectors for DS2000SPE-3 Series		
Reference	On Power Supply	Mating Connector or Equivalent
AC Input Connector	IEC320-C20	IEC320-C19
Output Connector	Card-edge	FCI power blade 10107844-002LF or equivalent

MECHANICAL SPECIFICATIONS

LED Indicator Definitions

LED INDICATOR



One bi-color (green/amber) LED at the power supply front provides the status signal. The status LED conditions are shown on the below table.

Conditions	LED Status
AC Input = ON, V_{SB} = ON, V_O = ON	Solid Green
AC Input = ON, V_{SB} = ON, V_O = OFF	Blinking Green
V_O = OCP / OVP / OTP / FAN FAULT	Blinking Amber
V_{SB} = OCP / OVP / OTP / FAN FAULT, V_O = OFF	Off
No AC input to PSU with external 12V	Blinking Amber

MECHANICAL SPECIFICATIONS

Weight

The DS2000SPE-3 series power supply weight is 1142g/2.51lbs maximum.

ENVIRONMENTAL SPECIFICATIONS

EMC Immunity

DS2000SPE-3 series power supply is designed to meet the following EMC immunity specifications.

Table 6. Environmental Specifications	
Document	Description
FCC 47CFR 15 Subpart B / CISPR22/ EN55022, and EN300386 Class A	Conducted and Radiated EMI Limits
IEC/EN61000-3-2	Harmonic Currents
IEC/EN61000-3-3	Voltage Fluctuations
IEC/EN61000-4-2	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test: +/-15KV air, +/-8KV contact discharge. Performance - Criteria B
IEC/EN61000-4-3	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test: Performance - Criteria A
IEC/EN61000-4-4	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Electrical fast transient/burst immunity test: 2KV for AC power port. Performance - Criteria B 0.5KV for DC ports, I/O and signal ports. Performance - Criteria A
IEC/EN61000-4-5	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Surge test: 2KV common mode and 1KV differential mode for AC ports. Performance - Criteria B
IEC/EN61000-4-6	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Conducted, electromagnetic field immunity test. Performance - Criteria A
IEC/EN61000-4-11	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Voltage dips and interruptions: Criteria A: >95% reduction for 10ms; Criteria C: >30% reduction for 500mS, or Criteria C: >95% reduction for 500mS.

ENVIRONMENTAL SPECIFICATIONS

Safety Certifications

The DS2000SPE-3 series 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 7. Safety Certifications for DS2000SPE-3 Series Power Supply		
Standard	File #	Description
UL62368		US and Canada Requirements
EN62368		European Requirements
CB Certificate and Report	SG PSB-OF-00425	All CENELEC Countries
CHINA CCC Approval	2015010907814394	China Requirements
BSMI	C1334061602831	Taiwan Requirement
CE Mark	9124	
UKCA Mark		UK Requirements

ENVIRONMENTAL SPECIFICATIONS

EMI Emissions

The DS2000SPE-3 series power supply has been designed to comply with the Class A limits of EMI requirements of EN55032 (FCC Part 15) and CISPR 22 (EN55032) for emissions and relevant sections of EN61000 (IEC61000) for immunity. The unit is enclosed inside a metal box, tested at 2000W using resistive load with cooling fan.

Conducted Emissions

The applicable standard for conducted emissions is EN55032 (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 DS2000SPE-3 series power supply has internal EMI filters to ensure the convertor's conducted EMI levels comply with EN55032 (FCC Part 15) Class A limits. The EMI measurements are performed with resistive loads at maximum rated loading.

Radiated Emissions

Unlike conducted EMI, radiated EMI performance in a system environment may differ drastically from that in a stand-alone power supply. It is thus recommended that radiated EMI be evaluated in a system environment. The applicable standard is EN55032 Class A (FCC Part 15). Testing AC-DC converters as a stand-alone component to the exact requirements of EN55032 can be difficult because the standard calls for 1m lead 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 converters could pass. However, the standard also states that an attempt will be made to maximize the disturbance consistent with the typical application by varying the configuration of the test sample.

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature

The DS2000SPE-3 series power supplies can start and operate within stated specifications at an ambient temperature from 0°C to 50°C under all load conditions with internal fan, allowable up to 60°C at derated output of 2.6%/°C above 50°C.

Forced Air Cooling

The DS2000SPE-3 series power supplies include internal cooling fans as part of the power supply assembly to provide forced air-cooling to maintain and control temperature of devices and ambient temperature in the power supply to appropriate levels. The standard direction of airflow is from the DC connector end to the AC connector end of the power supply.

The cooling fan is a variable speed fan. In standby mode power supply fan will operate at minimum speed to maintain component reliability at all load, line and ambient conditions. When 12.2Vdc output is enabled, power supply fan will operate at minimum achievable fan speed. Power supply fan speed control algorithms will vary the speed so that the critical component temperatures do not exceed safe operating levels. Fans will be powered from voltage source inside the power supply and from system side voltage source.

ENVIRONMENTAL SPECIFICATIONS

Storage and Shipping Temperature

The DS2000SPE-3 series power supply can be stored or shipped at temperatures between -40°C to $+70^{\circ}\text{C}$.

Altitude

The DS2000SPE-3 series power supply will operate within specifications at altitudes up to 16400 feet above sea level at 35°C input ambient temperature and derated output load at 85%.

The power supply will not be damaged when stored at altitudes up to 50,000 feet above sea level.

Humidity

Operating: Power supply will be designed to operate with no degradation of performance while operating in range of 5%RH to 95%RH non-condensing.

Non-Operating: Power supply will be designed to operate with no degradation of performance while operating in range of 5%RH to 95%RH non-condensing.

POWER AND CONTROL SIGNAL DESCRIPTIONS

AC Input Connector

This connector supplies the AC Mains to the DS2000SPE-3 series power supply.

- Pin 1 – L
- Pin 2 – N
- Pin 3 – Earth Ground

Output Connector – Power Blades

These pins provide the main output for the DS2000SPE-3 series power supply. The Main Output (V_O) and the Main Output Return pins are the positive and negative rails, respectively, of the V_O main output of the DS2000SPE-3 series power supply. The Main Output (V_O) is electrically isolated from the power supply chassis.

- P1-P8 – Main Output (V_O)
- P9-P18 – Main Output Return
- P19-P20 – Standby Output (V_{SB})
- P21-P28 – Main Output Return / Standby Output Return
- P29-P36 – Main Output (V_O)

Output Connector – Control Signals

The DS2000SPE-3 series power supply contains a 24 pins control signal header providing an analogue control interface, standby power and I²C interface signal connections.

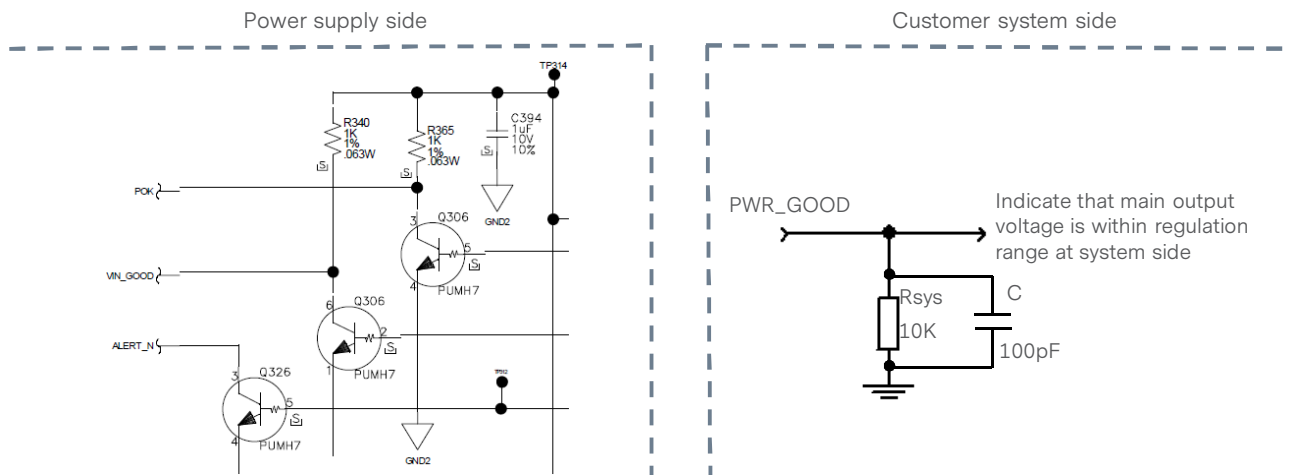
PS_PRESENT - (Pin S1)

This signal pin is grounded to the Standby return via a 220ohm resistor inside the power supply. It can be used to sense the power supply is inserted in the system by using a suitable pull-up with noise filter capacitor. Recommended pull-up resistor to 12V Standby is 8.2Kohm with a 3.0Kohm pull-down to ground. A 100pF decoupling capacitor is also recommended.

PWR_GOOD / PWOK - (Pin S4)

Signal used to indicate that main output voltage is within regulation range. The PWR_GOOD signal will be driven HIGH (>2.0V) when the output voltage is valid and will be driven LOW (<0.4V) when the output falls below the under-voltage threshold. This signal also gives an advance warning when there is an impending power loss due to loss of AC input or system shutdown request.

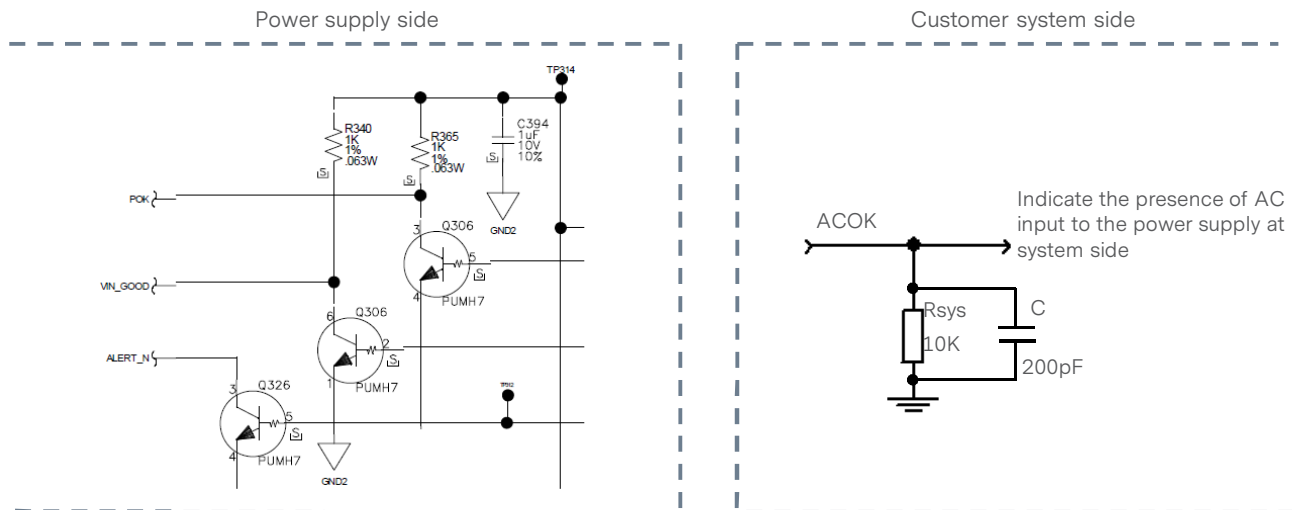
This is an open collector/drain output. This pin is pulled high by a 1.0Kohm resistor connected to 3.3V inside the power supply. It is recommended that this pin is connected to a 100pF decoupling capacitor and pulled down by a 10Kohm resistor.



POWER AND CONTROL SIGNAL DESCRIPTIONS

ACOK - (Pin S5)

Signal used to indicate the presence of AC input to the power supply. A logic level HIGH (>2.0V) will indicate that the AC input to the power supply is within the operating range while a logic level LOW (0.4V) will indicate that AC has been lost. This is an open collector/drain output. This pin is pulled high by a 1.0Kohm resistor connected to 3.3V inside the power supply. It is recommended that this pin be connected to a 200pF decoupling capacitor and pulled down by a 100Kohm resistor.

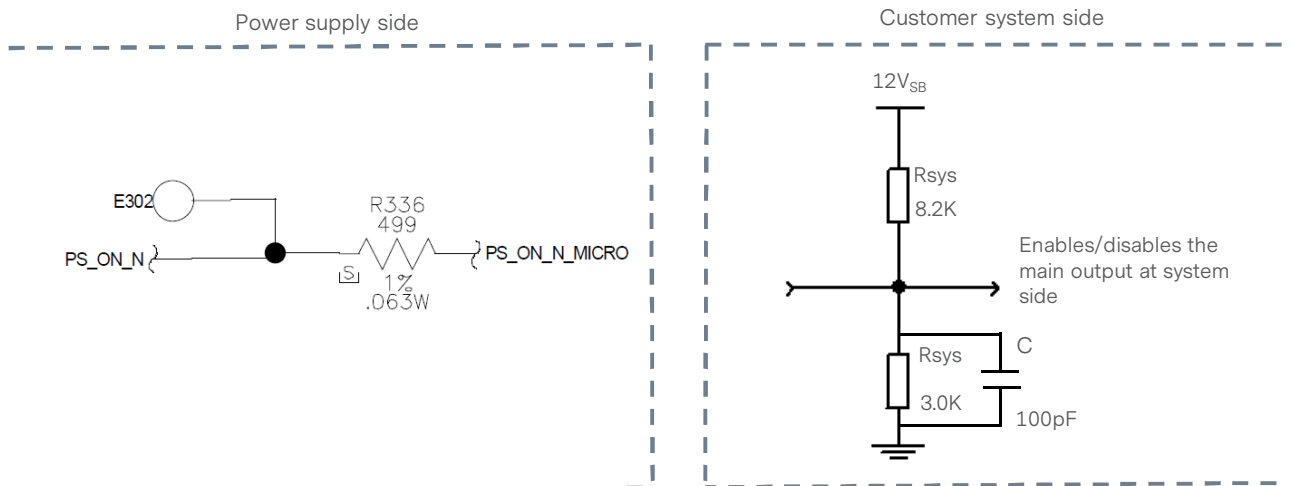


I_SHARE (Current Share Bus) - (Pin S7)

The DS2000SPE-3 supports active current sharing through a single wire connection between the power supplies. This input/output signal pin allows two or more power supplies to share the main output load current to increase the overall power capability or to operate the units in a N+N configuration for redundancy purposes. When two or more power supplies are connected and operating in parallel, the sharing accuracy between units must be within 5% of rated output current.

PS_ON_L - (Pin S13)

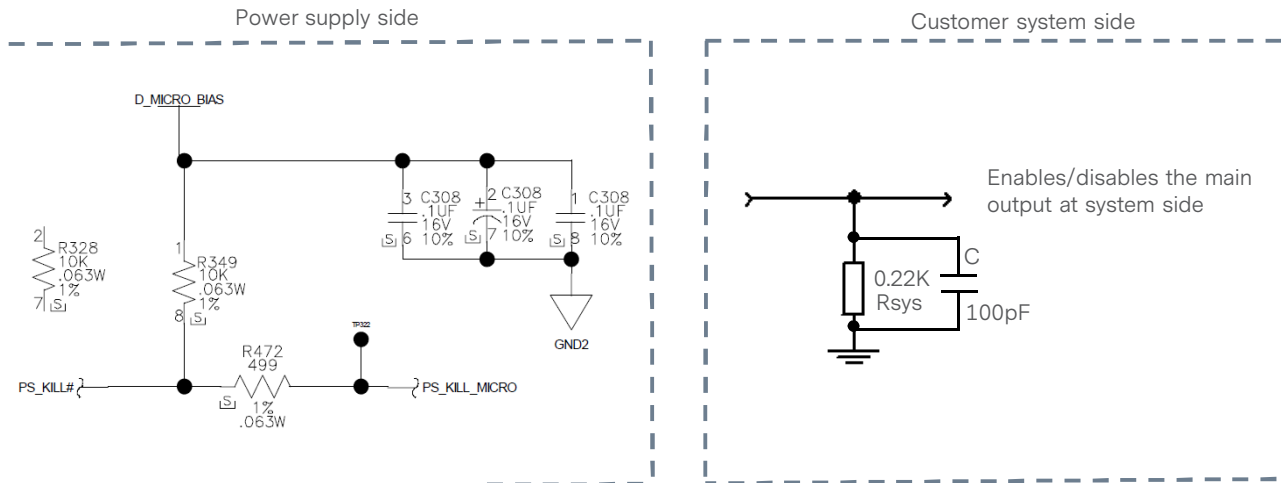
This signal input pin controls the normal turning ON and Off of the main output of the DS2000SPE-3 power supply. The power supply main output (V_O) will be enabled when this signal is pulled low (<0.8V) by the system. The Power supply output (except V_{SB} output) will be disabled when this signal is pulled high (>2.0V). This signal can be pulled high to 3.3V maximum. Recommended pull-up resistor to 12V V_{SB} is 8.2Kohm with a 3.0Kohm pull-down to ground. A 100pF decoupling capacitor is also recommended. For proper power supply operation, it is recommended to provide separate PSON signal to each unit in a system.



POWER AND CONTROL SIGNAL DESCRIPTIONS

PS_KILL_L - (Pin S14)

This signal has the shortest pin in the output connector. It functions as the first break / last mate. This enables or disables the 12V main output of the power supply. When this signal is shorted to ground by the system, the 12.2V main output is enabled. When this signal is opened by removal of the power supply from the system, the main output will shut down. The recommended pull-down resistor is 220ohm. A 100pF decoupling capacitor is also recommended. Standby output will remain on.



SDA, SCL, and PS_INTERRUPT_L - (Pins S17, S19 and S9)

Please refer to "Communication Bus Descriptions" section.

Main Output Remote Sense Return, Main Output Remote Sense - (Pins S21, S23)

The main output of the DS2000SPE-3 is equipped with a remote sensing capability that will compensate for a power path drop around the entire loop of 200 millivolt. This feature is implemented by connecting the main output remote sense (pin S23) and the main output remote sense return (pin S21) 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 DS2000SPE-3 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. This remote sense circuit will not raise the power supply's output voltage to the OVP trip level. Main output remote sense has no effect on the standby output (V_{SB}).

COMMUNICATION BUS DESCRIPTIONS

I²C Bus Signals

The DS2000SPE-3 series power supply contains enhanced monitor and control functions implemented via the I²C bus. The DS2000SPE-3 series I²C functionality (PMBus™ and FRU data) can be accessed via the output connector control signals. The communication bus is powered either by the internal 3.3V supply or from an external power source connected to the standby output (i.e. accessing an unpowered power supply as long as the standby output of another power supply connected in parallel is on).

If units are connected in parallel or in redundant mode, the standby outputs must be connected together in the system. Otherwise, the I²C bus will not work properly when a unit is inserted into the system without the AC source connected.

Note: PMBus™ functionality can be accessed only when the PSU is powered-up. Guaranteed communication I²C speed is 100KHz.

SDA, SCL (I²C Data and Clock Signals) - (Pins S17, S19)

I²C serial data and clock bus - there's no internal bias for these pins. These pins must be pulled-up in the system by a 2.2Kohm resistor to 3.3V and a 200pF decoupling capacitor at the system side.

PS_INTERRUPT_L - (Pin S9)

PS_INTERRUPT_L is used to send a signal to the system that a fault in the power supply occurred. This signal is normally logic level HIGH. It will go to a LOW logic level when a fault bit has been set in the power supply's status register. This event can be triggered by faults such as OVP, OCP, OTP, and fan fault. This signal can be cleared by a CLEAR_FAULT command. Recommended pull-up resistor to 12V_{SB} is 8.2Kohm with a 3.0Kohm pull-down to ground. A 200pF decoupling capacitor is also recommended.

I²C Bus Communication Interval

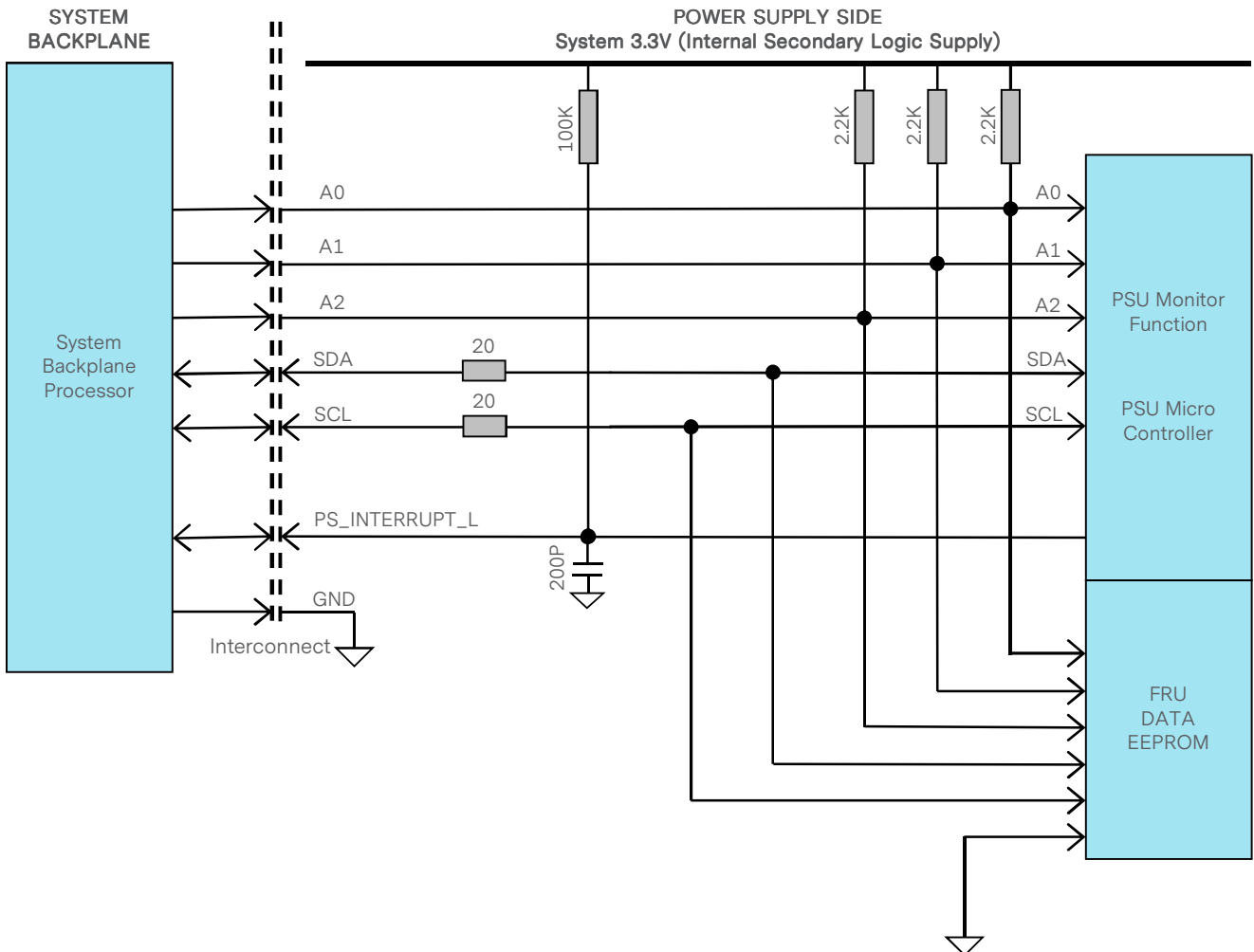
The interval between two consecutive I²C communications to the power supply must be at least 15ms to ensure proper monitoring functionality.

I²C Bus Signal Integrity

The noise on the I²C bus (SDA, SCL lines) due to the power supply will be less than 300mV peak-to-peak. This noise measurement should be made with an oscilloscope bandwidth limited to 100MHz. Measurements must be made at the power supply output connector with 2.2Kohm resistors pulled up to 3.3V source and a decoupling 47pF ceramic capacitors to standby output return.

COMMUNICATION BUS DESCRIPTIONS

I²C Bus Internal Implementation, Pull-ups and Bus Capacitances



I²C Bus - Recommended external pull-ups

Electrical and interface specifications of I²C signals (referenced to standby output return pin, unless otherwise indicated):

Parameter	Condition	Symbol	Min	Type	Max	Unit
SDA, SCL Internal Pull-up Resistor		R_{int}	No pull-up resistor			
SDA, SCL Recommended External Bus Capacitance		C_{int}	-	200	-	pF
Recommended External Pull-up Resistor	1 to 6 PSU	R_{ext}	-	2.2	-	Kohm

COMMUNICATION BUS DESCRIPTIONS

Logic Levels

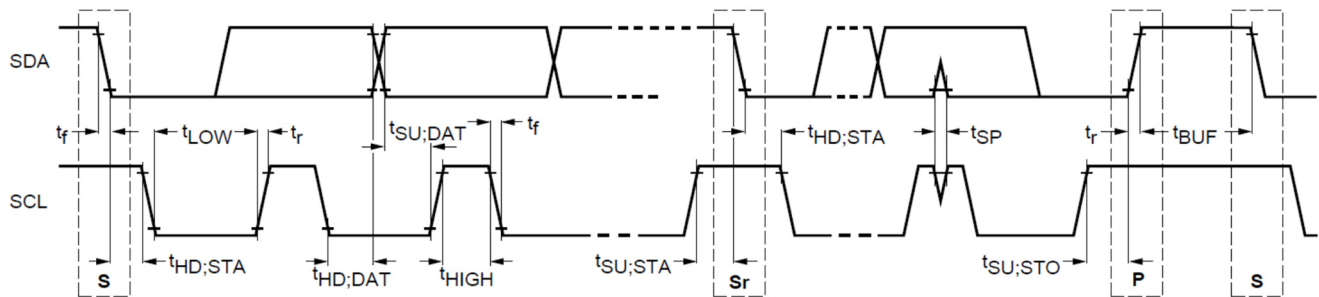
DS2000SPE-3 series power supply I²C communication bus will respond to logic levels as per below:

Logic High: 3.3V nominal (Spec is 2.1V to 5.5V)**

Logic Low: 500mV nominal (Spec is 800mV max)**

**Note: Artesyn 73-769-001 I²C adapter was used.

Timings



Parameter	Symbol	Standard-Mode Specs		Actual Measured		Unit
		Min	Max			
SCL clock frequency	f _{SCL}	0	100	100		KHz
Hold time (repeated) START condition	t _{HD;STA}	4.0	-	4.7		uS
LOW period of SCL clock	t _{LOW}	4.7	-	19		uS
HIGH period of SCL clock	t _{HIGH}	4.0	50	3.3		uS
Setup time for repeated START condition	t _{SU;STA}	4.7	-	5.2		uS
Data hold time	t _{HD;DAT}	0	3.45	0.4		uS
Data setup time	t _{SU;DAT}	250	-	4800		nS
Rise time	t _r	-	1000	SCL = 950	SDA = 999	nS
Fall time	t _f	-	300	SCL = 130	SDA = 140	nS
Setup time for STOP condition	t _{SU;STO}	4.0	-	5.8		uS
Bus free time between a STOP and START condition	t _{BUF}	4.7	-	31.4		uS

COMMUNICATION BUS DESCRIPTIONS

Device Addressing

The DS2000SPE-3 series will respond to supported commands on the I²C bus that are addressed according to pins A0, A1 and A2 pins of output connector.

Address pins are held HIGH by default via pulled up to internal 3.3V supply with a 2.2K resistor. To set the address as "0", the corresponding address line should be pulled down to logic ground level. Below table shows the address of the power supply with A0, A1 and A2 pins set to either "0" or "1".

PSU Slot	Slot ID Bits			PMBus™ Address	
	A2	A1	A0	WRITE	READ
1	0	0	0	B0	B1
2	0	0	1	B2	B3
3	0	1	0	B4	B5
4	0	1	1	B6	B7
5	1	0	0	B8	B9
6	1	0	1	BA	BB
7	1	1	0	BC	BD
8	1	1	1	BE*	BF

*Note - Default address when A0, A1 and A2 are left open.

COMMUNICATION BUS DESCRIPTIONS

Reporting Functions

The power supply is capable of monitoring and controlling functions implemented via the I²C bus. This will use the SDA and SCL pins. The power supply monitor operates as an I²C slave device.

The accuracy of the report functions will be as follows:

Firmware Reporting and Monitoring			
Output loading	0% to 10%	10% to 20%	20% to 100%
Input voltage	±5%		
Input current	±0.07A fixed error	±5%	
Input power	±5W fixed error up to 100W	±5%	
Output voltage	±5%		±2%
Output current	±0.8A for <10% load	±10%	
Temperature	±5°C on the operating range		
Fan speed	±250RPM		

PMBus	Yes
Remote ON/OFF	Yes

Note - Accuracy of input parameters applicable at nominal lines only.

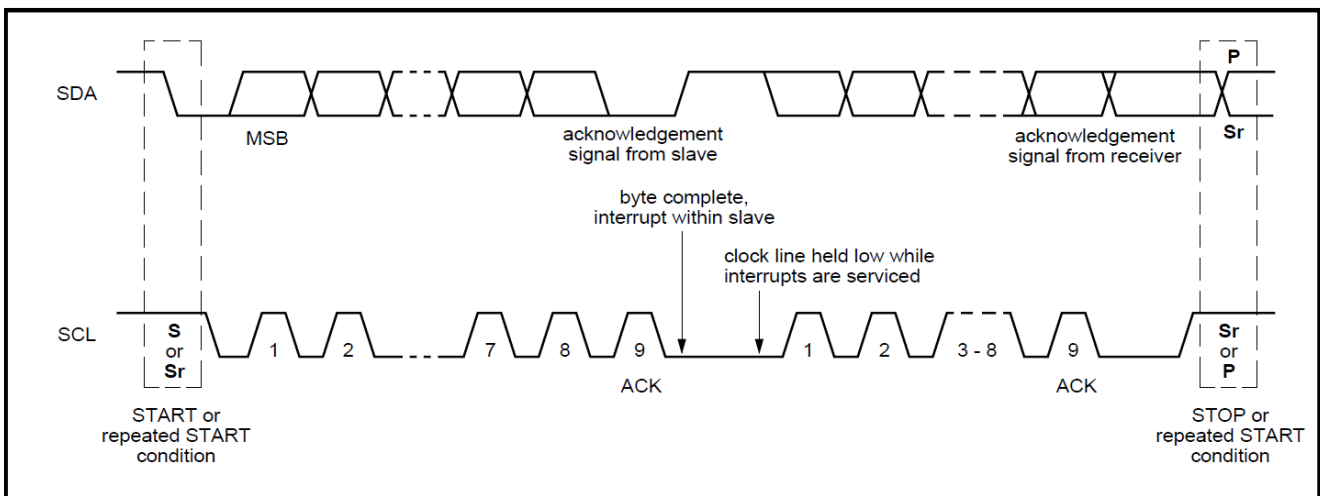
COMMUNICATION BUS DESCRIPTIONS

I²C Clock Synchronization

The DS2000SPE-3 series power supply applies clock stretching. An addressed slave power supply holds the clock line (SCL) low after receiving (or sending) a byte, indicating that it is not yet ready to process more data. The system master that is communicating with the power supply will attempt to raise the clock to transfer the next bit but must verify that the clock line was actually raised. If the power supply is clock stretching, the clock line will still be low (because the connections are open-drain).

The maximum time-out condition for clock stretching for DS2000SPE-3 series is 25 milliseconds.

The power supply has a command completion timeout of 100 milliseconds. That is a single transaction (from START to STOP condition) must be finished within 100 milliseconds.



COMMUNICATION BUS DESCRIPTIONS

FRU (EEPROM) Data

The FRU (Field Replaceable Unit) data format is compliant with the Intel IPMI v1.0 specification. FRU data storage and retrieval is performed using 0xA0 address.

The DS2000SPE-3 series uses 1 page of EEPROM for FRU purpose. A page of EEPROM contains up to 256 byte-sized data locations.

Where:	OFFSET	-The OFFSET denotes the address in decimal format of a particular data byte within DS2000SPE-3 series EEPROM.
	VALUE	-The VALUE details data written to a particular memory location of the EEPROM.
	DEFINITION	-The contents DEFINITION refers to the definition of a particular data byte.

DS2000SPE-3 series FRU (EEPROM) Data:

OFFSET		DEFINITION (REMARKS)	SPEC VALUE	
(DEC)	(HEX)		(DEC)	(HEX)
COMMON HEADER, 8 BYTES				
0	00	FORMAT VERSION NUMBER (Common header) 7:4 - Reserved, write as 0000b 3:0 - Format version number = 1h for this specification	1	01
1	01	INTERNAL USE AREA OFFSET	28	1C
2	02	CHASSIS INFO AREA OFFSET	1	01
3	03	BOARD INFO AREA OFFSET	0	00
4	04	PRODUCT INFO AREA OFFSET	5	05
5	05	MULTI RECORD AREA OFFSET	14	0E
6	06	PAD (Not required, do not reserve)	0	00
7	07	ZERO CHECK SUM (256 - (Sum of bytes 0 to 6))	207	CF
CHASSIS INFO AREA (24 BYTES)				
8	08	FORMAT VERSION NUMBER (Default value is 0.)	1	01
9	09	CHASSIS INFO AREA LENGTH (Default value is 0.)	4	04
10	0A	CHASSIS TYPE (Default value is 0.)	0	00
11	0B	CHASSIS PART NUMBER Type/Length CAh (if used) Type = "ASCII+LATIN1" = (11)b length = 10 bytes = (001010)b	202	CA
12	0C	CHASSIS PART NUMBER BYTES (Default value is 0.)	0	00
13	0D		0	00
14	0E		0	00
15	0F		0	00
16	10		0	00
17	11		0	00
18	12		0	00
19	13		0	00
20	14		0	00
21	15		0	00
22	16	CHASSIS SERIAL NUMBER Type/Length CFH (if used) Type = "ASCII+LATIN1" = (11)b length = 7 bytes = (001111)b	207	CF
23	17	CHASSIS SERIAL NUMBER BYTES , default value is 0.	0	00
24	18		0	00
25	19		0	00
26	1A		0	00
27	1B		0	00
28	1C		0	00
29	1D		0	00
30	1E		0	00
31	1F		0	00
32	20		0	00

COMMUNICATION BUS DESCRIPTIONS

DS2000SPE-3 series FRU (EEPROM) Data:

OFFSET		DEFINITION (REMARKS)	SPEC VALUE	
(DEC)	(HEX)		(DEC)	(HEX)
33	21	CHASSIS SERIAL NUMBER BYTES , default value is 0.	0	00
34	22		0	00
PRODUCT INFORMATION AREA, 72 BYTES				
35	23	FORMAT VERSION NUMBER	0	00
36	24		0	00
37	25		0	00
38	26	End Tag (0C1h if used.)	193	C1
39	27	ZERO CHECK SUM (From 8d to 30d if used.)	161	A1
PRODUCT INFO AREA, 72 BYTES				
40	28	FORMAT VERSION NUMBER (Product Info Area) 7:4 - Reserved, write as 0000b 3:0 - Format Version Number = 1h for this specification	1	01
41	29	PRODUCT INFO AREA LENGTH (In multiples of 8 bytes)	9	09
42	2A	Language (English)	25	19
43	2B	MANUFACTURER NAME Type/Length Type = "ASCII+LATIN1" = (11)b length = 7 bytes = (000111)b 7:6 - (11)b, 8-bit ASCII + Latin 1, 5:0 - (000101)b, 5-byte allocation	199	C7
44	2C	"A" = 41h	65	41
45	2D	"R" = 52h	82	52
46	2E	"T" = 54h	84	54
47	2F	"E" = 45h	69	45
48	30	"S" = 53h	83	53
49	31	"Y" = 59h	89	59
50	32	"N" = 4Eh	78	4E
51	33	PRODUCT NAME Type/Length Type = "ASCII+LATIN1" = (11)b length = 16 bytes = (010000)b	208	D0
52	34	"D"	68	44
53	35	"S"	83	53
54	36	"2"	50	32
55	37	"0"	48	30
56	38	"0"	48	30
57	39	"0"	48	30
58	3A	"S"	83	53
59	3B	"P"	80	50
60	3C	"E"	69	45
61	3D	"_"	45	2D
62	3E	"3"	51	33
63	3F		00	00
64	40		00	00
65	41		00	00
66	42		00	00
67	43		00	00
68	44	PRODUCT PART/MODEL NUMBER Type/Length Type = "ASCII+LATIN1" = (11)b length = 16 bytes = (010000)b	208	D0

COMMUNICATION BUS DESCRIPTIONS

DS2000SPE-3 series FRU (EEPROM) Data:

OFFSET		DEFINITION (REMARKS)	SPEC VALUE	
(DEC)	(HEX)		(DEC)	(HEX)
69	45	"D"	68	44
70	46	"S"	83	53
71	47	"2"	50	32
72	48	"0"	48	30
73	49	"0"	48	30
74	4A	"0"	48	30
75	4B	"S"	83	53
76	4C	"P"	80	50
77	4D	"E"	69	45
78	4E	"_"	45	2D
79	4F	"3"	51	33
80	50		00	00
81	51		00	00
82	52		00	00
83	53		00	00
84	54		00	00
85	55	PRODUCT VERSION NUMBER Type/Length (C2h) Type = "ASCII+LATIN1" = (11)b length = 2 bytes = (000010)b	194	C2
		PRODUCT VERSION NUMBER BYTES Refer to Current iPro TLA Rev.		
86	56		65	41
87	57		65	41
88	58	PRODUCT SERIAL NUMBER Type/Length Type = "ASCII+LATIN1" = (11)b length = 13 bytes = (001101)b	205	CD
		Product Model ID		
89	59	L	76	4C
90	5A	6	54	36
91	5B	6	54	36
92	5C	7	55	37
		MANUFACTURING YEAR AND WEEK CODE		
93	5D	"W"=57h (Per unit)	87	57
94	5E	"W"=57h (Per unit)	87	57
		UNIQUE SERIAL NUMBER		
		"SSSS"		
95	5F	"S" = 53 (Per unit)	83	53
96	60	"S" = 53 (Per unit)	83	53
97	61	"S" = 53 (Per unit)	83	53
98	62	"S" = 53 (Per unit)	83	53
		MODEL REVISION, Astec model rev, see latest model rev in iPRO		
99	63		65	41
100	64		65	41
		MANUFACTURING LOCATION		
101	65	"P" for "Laguna, Philippines" In Decimal = 080; In Hex = 50H	80	50
102	66	Eng Tag	193	C1
		PAD (reserved) (Default value is 0.)		
103	67		0	00
104	68		0	00
		ZERO CHECK SUM (256 - (sum of bytes 40 to 104)) per unit		
105	69		00	00
106	6A		00	00
107	6B		00	00
108	6C		00	00
109	6D		00	00
110	6E		00	00
111	6F		129	81

COMMUNICATION BUS DESCRIPTIONS

DS2000SPE-3 series FRU (EEPROM) Data:

OFFSET		DEFINITION (REMARKS)	SPEC VALUE	
(DEC)	(HEX)		(DEC)	(HEX)
MULTI RECORD AREA, 88 BYTES				
112	70	Power Supply Record Header Record type = 00 for power supply	0	00
113	71	End of list / Record format version number	2	02
114	72	Record length of power supply record	24	18
115	73	Record CHECKSUM of power supply record (Zero CHECKSUM) (256-(sum of bytes 117 to 140))	42	2A
116	74	Header CHECKSUM of power supply record header (Zero CHECKSUM) (256-(sum of bytes 112 to 115))	188	BC
POWER SUPPLY RECORD				
117	75	Overall Capacity of the Power Supply 2 bytes sequence	208	D0
118	76	2000W = 07D0H	7	07
119	77	Peak VA 2 bytes sequence	252	FC
120	78	2300VA = 08FCH	8	08
121	79	Inrush Current, 50A In Decimal = 50, In Hex = 32H	50	32
122	7A	Inrush Interval, 200mS In Decimal = 200, In Hex = C8H	200	C8
123	7B	Low End Input Voltage Range 1(10mV), (90V / 10mV) 9000 = 2328H 2 bytes sequence	40	28
124	7C	(90V/10mV) 9000 = 2328H	35	23
125	7D	High End Input Voltage Range 1(10mV), (154V/10mV) 2 bytes sequence	40	28
126	7E	(154V/10mV) 15400 = 3C28H	60	3C
127	7F	Low End Input Voltage Range 2(10mV), (180V/10mV) 2 bytes sequence	80	50
128	80	(180V/10mV) 18000 = 4650H	70	46
129	81	High End Input Voltage Range 2(10mV), (264V/10mV) 2 bytes sequence	32	20
130	82	(264V/10mV) 26400 = 6720H	103	67
131	83	Low End Input Frequency Range, 47Hz = 2FH	47	2F
132	84	Low End Input Frequency Range, 63Hz = 3FH	63	3F
133	85	AC Dropout Tolerance in ms, 10mS= 0BH	11	0B
134	86	Binary Flags , "1" indicates function supported and a "0" indicates function not supported. Bits 7-5: RESERVED, write as 000B Bit 4: Tachometer Pulses Per Rotation / Predictive Fail Polarity BIT = 1 Bit 3: Hot Swap / Redundancy Support BIT = 1 Bit 2: Auto Switch Support BIT = 1 Bit 1: Power Factor Correction Support BIT = 1 Bit 0: Predictive Fail Support BIT = 0	14	0E
135	8	Peak Wattage Capacity and Hold Up Time 15-12: Hold Up Time in Seconds = 11 msec	208	D0
136	88	11-0: Peak Capacity in Watts = 2000W	7	07
137	89	Combined Wattage Byte 1: 0000 0000 = 00H = 00d (12V0 - voltage1) Byte 2 and Byte 3: 00H, 00H	0	00
138	8A	2000W = 07D0H	208	D0
139	8B	For DS2000SPE-3 = 07D0h;	7	07
140	8C	Predictive Fail Tachometer Lower Threshold , not applicable. Predictive failure is not supported.	0	00

COMMUNICATION BUS DESCRIPTIONS

DS2000SPE-3 series FRU (EEPROM) Data:

OFFSET		DEFINITION (REMARKS)	SPEC VALUE	
(DEC)	(HEX)		(DEC)	(HEX)
12V DC OUTPUT RECORD HEADER				
141	8D	Record type = 01 for DC Output record	1	01
142	8E	End of list / Record format version number for 12V DC output record	2	02
143	8F	Record length of 12V DC output record	13	0D
144	90	Record CHECKSUM of 12V DC output record (Zero CHECKSUM) (256-(sum of bytes 146 to 158))	72	48
145	91	Header CHECKSUM of 12V DC output record header (Zero CHECKSUM) (256-(sum of bytes 141 to 144))	168	A8
12V OUTPUT RECORD				
146	92	Output Information, Bit 7: Standby Information = 0B Bits 6-4: Reserved, write as 000B Bits 3-0: Output Number 1 = 001B	1	01
147	93	Nominal Voltage 2 bytes sequence (12.2V / 10mV) 1220 = 04C4H	196	C4
148	94		4	04
149	95	Maximum Negative Voltage Deviation 2 bytes sequence (11.60V/10mV) 1160 = 04C4H	136	88
150	96		4	04
151	97	Maximum Positive Voltage Deviation 2 bytes sequence (12.80V/10mV)1280 =0500H	0	00
152	98		5	05
153	99	Ripple and Noise pk-pk (mV), 2 bytes sequence 180 = B4H	180	B4
154	9A		0	00
155	9B	Minimum Current Draw (10mA), 2 bytes sequence (1A/10mA) 100 = 64H	100	64
156	9C		0	00
157	9D	Maximum Current Draw (10mA), 2 bytes sequence (163.9/10mA) 16390 = 4006H	6	06
158	9E		64	40
VSB OUTPUT RECORD HEADER				
159	9F	Record type = 01 for DC output record	1	01
160	A0	End of list / Record format version number for 12VSB output record	2	02
161	A1	Record length of 12V _{SB} output record	13	0D
162	A2	Record CHECKSUM of 12V _{SB} output record (Zero CHECKSUM) (256-(sum of bytes 164 to 176))	79	4F
163	A3	Header CHECKSUM of 12V _{SB} output record header (Zero CHECKSUM) (256-(sum of bytes 159 to 162))	161	A1
SB OUTPUT RECORD				
164	A4	Output Information, 002 = 02H Bit 7: Standby Information = 1B Bits 6-4: Reserved, write as 000B Bits 3-0: Output Number 2 = 0010B	130	82
165	A5	Nominal Voltage 2 bytes sequence (12V/10mV) 1200 = 04B0H	176	B0
166	A6		4	04
167	A7	Maximum Negative Voltage Deviation 2 bytes sequence (11.4V/10mV) 1140 = 0474H	116	74
168	A8		4	04
169	A9	Maximum Positive Voltage Deviation 2 bytes sequence (12.6V/10mV) 1260 = 04ECH	236	EC
170	AA		4	04

COMMUNICATION BUS DESCRIPTIONS

DS2000SPE-3 series FRU (EEPROM) Data:

OFFSET		DEFINITION (REMARKS)	SPEC VALUE	
(DEC)	(HEX)		(DEC)	(HEX)
171	AB	Ripple and Noise pk-pk (mV) 2 bytes sequence 180 = B4H	180	B4
172	AC		0	00
173	AD	Minimum Current Draw 2 bytes sequence (0.0A/10mA) 0 = 00H	0	00
174	AE		0	00
175	AF	Maximum Current Draw 2 bytes sequence (3.5A/10mA) 350 = 015EH	94	5E
176	B0		1	01
OEM RECORD HEADER				
177	B1	Record type = C0H for OEM record	192	C0
178	B2	End of list / Record format version number	130	82
179	B3	Record length of OEM record	42	2A
180	B4	Record CHECKSUM of OEM record (Zero CHECKSUM) (256-(sum of bytes 182 to 223))	00	00
181	B5	Header CHECKSUM of OEM record header (Zero CHECKSUM) (256-(sum of bytes 177 to 180))	148	94
182	B6	Manufacturer ID (3 bytes, default is 0)	0	00
183	B7	RESERVED	0	00
184	B8	RESERVED	0	00
185	B9	RESERVED	0	00
186	BA	RESERVED	0	00
187	BB	RESERVED	0	00
188	BC	RESERVED	0	00
189	BD	RESERVED	0	00
190	BE	RESERVED	0	00
191	BF	RESERVED	0	00
192	C0	RESERVED	0	00
193	C1	RESERVED	0	00
194	C2	RESERVED	0	00
195	C3	PAD (reserved), default value is 0.	0	00
196	C4		0	00
197	C5		0	00
198	C6		0	00
199	C7		0	00
200	C8		0	00
201	C9		0	00
202	CA		0	00
203	CB		0	00
204	CC		0	00
205	CD		0	00
206	CE		0	00
207	CF		0	00
208	D0		0	00
209	D1		0	00
210	D2		0	00
211	D3		0	00
212	D4		0	00
213	D5		0	00
214	D6		0	00
215	D7		0	00
216	D8		0	00
217	D9		0	00
218	DA		0	00
219	DB		0	00
220	DC		0	00
221	DD		0	00
222	DE		0	00

COMMUNICATION BUS DESCRIPTIONS

DS2000SPE-3 series FRU (EEPROM) Data:

OFFSET		DEFINITION (REMARKS)	SPEC VALUE	
(DEC)	(HEX)		(DEC)	(HEX)
223	DF	Manufacturer ID (3 bytes, default is 0)	0	00
INTERNAL USE AREA, 32 BYTES				
224	E0	RESERVED, default value is 0.	0	00
225	E1		0	00
226	E2		0	00
227	E3		0	00
228	E4		0	00
229	E5		0	00
230	E6		0	00
231	E7		0	00
232	E8		0	00
233	E9		0	00
234	EA		0	00
235	EB		0	00
236	EC		0	00
237	ED		0	00
238	EE		0	00
239	EF		0	00
240	F0		0	00
241	F1		0	00
242	F2		0	00
243	F3		0	00
244	F4		0	00
245	F5		0	00
246	F6		0	00
247	F7		0	00
248	F8		0	00
249	F9		0	00
250	FA		0	00
251	FB		0	00
252	FC		0	00
253	FD		0	00
254	FE		0	00
255	FF		0	00

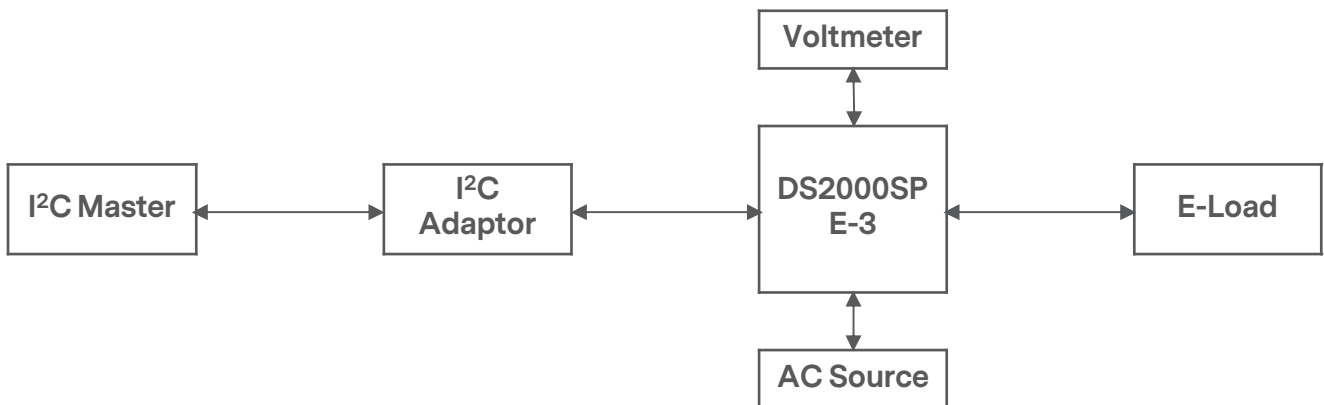
PMBus™ SPECIFICATIONS

The DS2000SPE-3 series is compliant with the industry standard PMBus™ protocol for monitoring and control of the power supply via the I²C interface port.

DS2000SPE-3 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 10h) by writing any of the following accordingly:

- Levels:
- 00h - Enable writing to all writeable commands
 - 20h - Disables write except 10h, 01h, 00h and 02h commands
 - 40h - Disables write except 10h, 01h, and 00h commands
 - 80h - Disable write except 0x00h

PMBus™ SPECIFICATIONS

The DS2000SPE-3 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
00h	PAGE	00	R	1	Hex	Valid input: 00h, 01h, FFh
01h	OPERATION	80	R/W	1	Bitmapped	Used to turn the unit ON/OFF in conjunction with the input CONTROL pin. It is also used to set output to upper or lower margin voltages.
	b7:6					01 - Immediate turn OFF (No sequencing) 10 - PSU ON
	b5:0					Reserved
02h	ON_OFF_CONFIG	1C	R	1	Bitmapped	Configures the combination of CONTROL pin and serial communication commands needed to turn the unit ON/OFF.
	b7:5					Reserved
	b4 - Enable CONTROL pin and serial communication control.	1				0 - Unit powers up any time power is present regardless of the state of CONTROL pin. 1 - Unit powers up as dictated by CONTROL pin and OPERATION command (b3:0).
	b3 - Serial communication control	1				0 - Unit ignores ON/OFF portion of the OPERATION command. 1 - Enables serial communication ON/OFF portion of OPERATION command. Requires CONTROL pin to be asserted for the unit to start and energize the output.
	b2 - Sets how the unit responds to CONTROL pin	1				0 - Unit ignores CONTROL pin. (ON/OFF controlled by OPERATION command). 1 - Unit requires CONTROL pin to be asserted to start the unit.
	b1 - CONTROL pin polarity	0				0 - Active low (Pull low to start the unit) 1 - Active high (Pull high to start the unit)
	b0 - CONTROL pin action	0				0 - Use programmed turn ON/OFF delay. 1 - Turn OFF the output and stop transferring energy to the output as fast as possible.
03h	CLEAR_FAULTS		S			
10h	WRITE_PROTECT	80	R/W	1	Bitmapped	Used to control writing to the PMBus™ device. 80h - Disables write except 10h 40h - Disables write except 10h, 01h, 00h 20h - Disables write except 10h, 01h, 00h, 02h and 21h commands. 00 - Enables write to all writeable commands.

PMBus™ SPECIFICATIONS

The DS2000SPE-3 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
19h	CAPABILITY	90	R	1	Bitmapped	Provides a way for the hosts system to determine some key capabilities of a PMBus™ device.
	b7 - Packet Error Checking					0 - PEC not supported 1 - PEC supported
	b6 - Maximum Bus Speed					0 - Maximum supported bus speed, 100KHz 1 - Maximum supported bus speed, 400KHz
	b5 - SMBALERT					0 - SMBus Alert Pin not supported. 1 - SMBus Alert Pin supported.
	b4:0					Reserved
1Ah	QUERY	-	BR/BW	1	Bitmapped	
1Bh	SMBALERT_MASK		BR/BW	1	Bitmapped	
20h	VOUT_MODE	17	R	1	Bitmapped	Specifies the mode and parameters of output voltage related data formats.
21h	VOUT_COMMAND		R/W	2	Linear	Sets the output voltage reference. Vout command sends discreet value to change or trim output voltage.
24h	VOUT_MAX	1999	R	2	Linear	Sets the max adjustable output voltage limit.
30h	COEFFICIENTS	-	BW/BR	5	Hex	Use to retrieve the m, b and R coefficients, needed for DIRECT data format.
	byte 5					R byte
	byte 4:3					b low byte, b high byte
	byte 2:1					m low byte, m high byte
31h	POUT_MAX	11F4	R	2	Linear	Sets the operating power limit condition.
35h	VIN_ON	0058	R	2	Linear	Sets the value of input, in volts, at which the unit should start. ACGOOD
36h	VIN_OFF	0050	R	2	Linear	Sets the value of input, in volts, at which the unit should stop power conversion. ACBAD
3Ah	FAN_CONFIG_1_2	90	R	1	Bitmapped	Read only to reflect setting of fans.
	b7	1				1 - Fan is installed in position 1 0 - No fan is installed in position 1.
	b6	0				1 - Fan is commanded in RPM. 0 - Fan is commanded in DC.
	b5:4	01				00 - 1 pulse per revolution 01 - 2 pulses per revolution 10 - 3 pulses per revolution 11 - 4 pulses per revolution
	b3	0				1 - Fan is installed in position 2 0 - No fan is installed in position 2.

PMBus™ SPECIFICATIONS

The DS2000SPE-3 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
3Ah	b1:0	00				00 - 1 pulse per revolution 01 - 2 pulses per revolution 10 - 3 pulses per revolution 11 - 4 pulses per revolution
3Bh	FAN_COMMAND_1	0000	R/W	2	Linear	Adjusts the operation of the fans. The device may override the command, if it requires higher value, to maintain proper device temperature. RPM control - commands speeds from 0-65535 RPM. Duty cycle control - commands speeds from 0 to 100%.
40h	VOUT_OV_FAULT_LIMIT	1D00	R/W	2	Linear	Sets output over voltage threshold. (14.5V) Valid range: 13.5 to 14.5V
41h	VOUT_OV_FAULT_RESPONSE	80	R	1	Bitmapped	Unit latches OFF. Resets on PSON or CONTROL pin recycle or AC recycle.
42h	VOUT_OV_WARN_LIMIT	1D00	R/W	2	Linear	Sets over-voltage warning threshold.
43h	VOUT_UV_WARN_LIMIT	1480	R	2	Linear	Sets under-voltage warning threshold.
44h	VOUT_UV_FAULT_LIMIT	1480	R/W	2	Linear	Sets under-voltage fault threshold.
45h	VOUT_UV_FAULT_RESPONSE	80	R	1	Bitmapped	VOUT_UV_FAULT_RESPONSE
46h	IOUT_OC_FAULT_LIMIT	F30C	R/W	2	Linear	Sets the over current threshold in Amps. (195A)
47h	IOUT_OC_FAULT_RESPONSE	C0	R	1	Bitmapped	OCF ride through, if OCP persists.
4Ah	IOUT_OC_LV_WARN_LIMIT	F2BC	R/W	2	Linear	Sets the output over current warning threshold in Amps. (175A) Valid range: 175 to 213A
4Fh	OT_FAULT_LIMIT	007B	R/W	2	Linear	Secondary ambient temperature fault threshold in degree C. (123degC)
50h	OT_FAULT_RESPONSE	78	R	1	Bitmapped	Turn PSU OFF and will retry indefinitely. Supported enable/disable of protection and recoverability.
51h	OT_WARN_LIMIT	0075	R/W	2	Linear	Secondary ambient temperature warning threshold in degree C. Operating limit (117degC)
56h	VIN_OV_FAULT_RESPONSE	00	R	1	Bitmapped	Turn PSU OFF. Cleared upon AC recycle.
57h	VIN_OV_WARN_LIMIT	0113	R	2	Linear	Sets the threshold of input voltage that triggers high voltage warning.
58h	VIN_UV_WARN_LIMIT	0058	R	2	Linear	Sets the threshold of input voltage that triggers low voltage warning.
59h	VIN_UV_FAULT_LIMIT	0050	R/W	2	Linear	Sets input under-voltage threshold.

PMBus™ SPECIFICATIONS

The DS2000SPE-3 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
5Ah	VIN_UV_FAULT_RESPONSE	F8	R	1	Bitmapped	
5Eh	POWER_GOOD_ON	1733	R/W	2	Linear	Sets the threshold by which the Power Good signal is asserted.
5Fh	POWER_GOOD_OFF	15CC	R/W	2	Linear	Sets the threshold by which the Power Good signal is de-asserted.
60h	TON_DELAY	0064	R/W	2	Linear	Sets the time (sec), from start condition (power ON) until the output starts to rise. Default=100ms
61h	TON_RISE	0064	R	2	Linear	Sets the time (ms), for the output rises from 0 to regulation. (100ms max) Default=100ms
62h	TON_MAX_FAULT_LIMIT	C24D	R/W	2	Linear	Default=2.3S
63h	TON_MAX_FAULT_RESPONSE	80	R	1	Bitmapped	
64h	TOFF_DELAY	0002	R/W	2	Linear	Sets the time (ms), from a stop condition (power OFF) until the output starts to drop (converter OFF). Default=2.0S
6Ah	POUT_OP_WARN_LIMIT	120D	R	2	Linear	Default=2100W
78h	STATUS_BYTE	00	R	1	Bitmapped	Returns the summary of critical faults.
	b7 - BUSY	-				Not supported.
	b6 - OFF	-				Unit is OFF.
	b5 - VOUT_OV	-				Output over-voltage fault has occurred.
	b4 - IOUT_OC	-				Output over-current fault has occurred.
	b3 - VIN_UV	-				An input under-voltage fault has occurred.
	b2 - TEMPERATURE	-				A temperature fault or warning has occurred.
	b1 - CML	-				A communication, memory or logic fault has occurred.
b0 - NONE OF THE ABOVE	-				A Fault warning not listed in bits[7:1] has occurred.	
79h	STATUS_WORD	0000	R	2	Bitmapped	Summary of units fault and warning status.
	b15 - VOUT					An output voltage fault or warning has occurred
	b14 - IOUT/POUT					An output current or power fault or warning has occurred.
	b13 - INPUT					An input voltage, current or power fault or warning as occurred.
	b12 - MFR					A manufacturer specific fault or warning has occurred.
	b11 - POWER_GOOD#					The POWER_GOOD signal is de-asserted.
	b10 - FANS					A fan or airflow fault or warning has occurred.
	b9 - OTHER					Not supported

PMBus™ SPECIFICATIONS

The DS2000SPE-3 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
79h	b8 - UNKNOWN					Not supported
	b7 - BUSY					A fault was declared because the device was busy and unable to respond.
	b6 - OFF					Unit is OFF.
	b5 - VOUT_OV					Output over-voltage fault has occurred.
	b4 - IOUT_OC					Output over-current fault has occurred.
	b3 - VIN_UV					An input under-voltage fault has occurred.
	b2 - TEMPERATURE					A temperature fault or warning has occurred.
	b1 - CML					A communication, memory or logic fault has occurred.
	b0 - NONE_OF_THE_ABOVE					A fault or warning not listed in bits[7:1] of this byte has occurred.
7Ah	STATUS_VOUT	00	R/W	1	Bitmapped	Output voltage related faults and warnings.
	b7					VOUT over-voltage fault
	b6					VOUT over-voltage warning
	b5					VOUT under-voltage warning
	b4					VOUT under-voltage fault
	b3					VOUT_MAX warning, an attempt has been made to set output to a value higher than the highest permissible voltage. Not supported.
	b2					TON_MAX_FAULT
	b1					TOFF_MAX Warning. Not supported.
	b0					Not supported.
7Bh	STATUS_IOUT	00	R/W	1	Bitmapped	Output current related faults and warnings
	b7					IOUT over current fault
	b6					IOUT over current and low voltage shutdown fault. Not supported.
	b5					IOUT overcurrent warning
	b4					IOUT undercurrent fault. Not supported.
	b3					Current share fault. Not supported.
	b2					Power limiting. Not supported.
	b1					POUT overpower fault. Not supported.
	b0					POUT overpower warning.

PMBus™ SPECIFICATIONS

The DS2000SPE-3 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
7Ch	STATUS_INPUT	00	R/W	1	Bitmapped	Input related faults and warnings
	b7					VIN overvoltage fault
	b6					VIN overvoltage warning. Not supported.
	b5					VIN under-voltage warning
	b4					VIN under-voltage fault
	b3					Unit is OFF for insufficient input voltage.
	b2					IIN over current fault. Not supported.
	b1					IIN over current warning. Not supported.
	b0					PIN overpower warning. Not supported.
7Dh	STATUS_TEMPERATURE	00	R/W	1	Bitmapped	Temperature related faults and warnings
	b7					Over temperature fault.
	b6					Over temperature warning.
	b5					Under temperature warning. Not supported.
	b4					Under temperature fault. Not supported.
	b3:0					Reserved
7Eh	STATUS_CML	00	R/W	1	Bitmapped	Communications, Logic and Memory
	b7					Invalid or unsupported command received
	b6					Invalid data
	b5					Packet error check failed
	b4					Memory fault detect, CRC Error
	b3					Not supported.
	b2					Not supported.
	b1					Not supported.
	b0					Not supported.
81h	STATUS_FANS_1_2	00	R/W	1	Bitmapped	
	b7					Fan 1 fault
	b6					Fan 2 fault
	b5					Fan 1 warning
	b4					Fan 2 warning
	b3					Fan_1 speed overridden
	b2					Fan_2 speed overridden
	b1					Not used
	b0					Not used
86h	READ_EIN	-	R	6	Direct	Returns the accumulated input power over time.
87h	READ_EOUT	-	R	6	Direct	Returns the accumulated output power over time.
88h	READ_VIN	-	R	2	Linear	Returns input voltage in Volts ac.
89h	READ_IIN	-	R	2	Linear	Returns input current in Amperes.

PMBus™ SPECIFICATIONS

The DS2000SPE-3 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
8Bh	READ_VOUT	-	R	2	Linear	Returns the actual, measured voltage in Volts.
8Ch	READ_IOUT	-	R	2	Linear	Returns the output current in amperes.
8Dh	READ_TEMPERATURE_1	-	R	2	Linear	Primary side hotspot
8Eh	READ_TEMPERATURE_2	-	R	2	Linear	Secondary side hotspot
8Fh	READ_TEMPERATURE_3	-	R	2	Linear	Secondary side ambient
90h	READ_FAN_SPEED_1	-	R	2	Linear	Speed of fan 1
96h	READ_POUT	-	R	2	Linear	Returns the output power, in Watts.
97h	READ_PIN	-	R	2	Linear	Returns the input power, in Watts.
98h	PMBus™_REVISION	22	R	1	Bitmapped	Reads the PMBus™ revision number
	b7:4	0010				Part 1 Revision 0000 - Revision 1.0 0001 - Revision 1.1 0010 - Revision 1.2
	b3:0	0010				Part 2 Revision 0000 - Revision 1.0 0001 - Revision 1.1 0010 - Revision 1.2
99h	MFR_ID	"ARTESYN"	BR	-	ASCII	Abbrev or symbol of manufacturers name. ASCII (artesyn)
9Ah	MFR_MODEL	"DS2000SPE-3"	BR	15	ASCII	Manufacturers model number, ASCII format
9Bh	MFR_REVISION		BR	-	ASCII	Manufacturers, revision number, ASCII format
9Ch	MFR_LOCATION	"Philippines"	BR	-	ASCII	Manufacturers facility, ASCII format
9Dh	MFR_DATE	"YYMMDD"	BR	-	ASCII	Manufacture date, ASCII format structure: YYMMDD
9Eh	MFR_SERIAL		BR	-	ASCII	Unit serial number, ASCII format.
A0h	MFR_VIN_MIN	005A	R	2	Linear	Minimum Input Voltage (90Vac)
A1h	MFR_VIN_MAX	0108	R	2	Linear	Maximum Input Voltage (264Vac)
A2h	MFR_IIN_MAX	D333	R	2	Linear	Maximum Input Current (12.8A)
A3h	MFR_PIN_MAX	0A3F	R	2	Linear	Maximum Input Power, 2300W for high line and 1150W for low line)
A4h	MFR_VOUT_MIN	1733	R	2	Linear	Minimum Output Voltage Regulation window. (11.6V)
A5h	MFR_VOUT_MAX	199A	R	2	Linear	Maximum Output Voltage. Regulation window (12.8V)
A6h	MFR_IOUT_MAX	F290	R	2	Linear	Maximum Output Current (164A)
A7h	MFR_POUT_MAX	11F4	R	2	Linear	Maximum Output Power (2000W)
A8h	MFR_TAMBIENT_MAX	0037	R	2	Linear	Maximum Operating Ambient Temperature (Secondary ambient) (55degC)
A9h	MFR_TAMBIENT_MIN	0000	R	2	Linear	Minimum Operating Ambient Temperature (Secondary ambient) (0degC)

PMBus™ SPECIFICATIONS

The DS2000SPE-3 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
AAh	MFR_EFFICIENCY_LL	-	BR	14	Linear	Default: 115V, 200W, 88%, 500W, 91.5%, 1000W, 89%
ABh	MFR_EFFICIENCY_HL	-	BR	14	Linear	Default: 230V, 400W, 90%, 1000W, 94%, 2000W, 91%
B0h	USER_DATA_00	-	BR/BW		Hex	
E0h	FW_PRI_VERSION	-	BR	8	ASCII	
E1h	FW_SEC_VERSION	-	BR	8	ASCII	
F1h	ISP_UNLOCK_CODE		BR/BW	4	ASCII	
F2h	ISP_CTRL_CMD		R/W	1	Bitmapped	
F3h	ISP_CONFIG_STATUS		R	2	Bitmapped	
F4h	SP_FLASH_ADDR		BR/W	4	Direct	
F5h	ISP_FLASH_DATA.		BR/BW	16	Hex	

APPLICATION NOTES

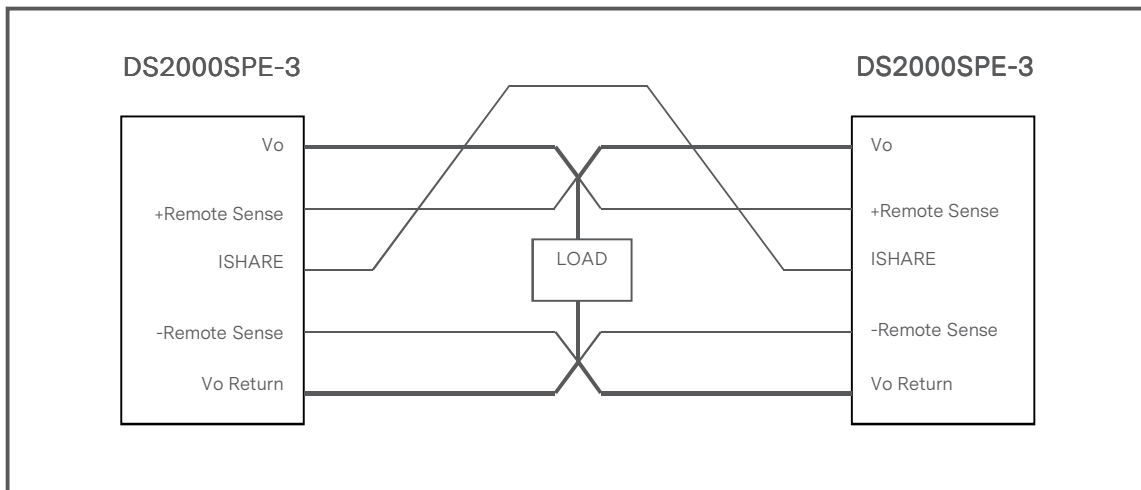
Current Sharing

The DS2000SPE-3 series main output V_O is equipped with current sharing capability. This will allow up to 6 power supplies to be connected in parallel for higher power application. Current share accuracy is typically 5% of full load. When supplying light loads between 10% and 100% of its rated load, the power supplies will share within 5% accuracy. Below 10% total loading, there is no guarantee of output current sharing.

Redundancy / Fault Tolerance

The DS2000SPE-3 series is able to current share with 2 (1+1) up to 6 (3+3) power supplies in parallel and operate in a hot swap/redundant N+N configuration where N=1, 2, or 3. The 12V V_{SB} outputs of the power supplies are connected together in the system so that a failure or hot swap of a redundant power supply does not cause these outputs to go out of regulation in the system.

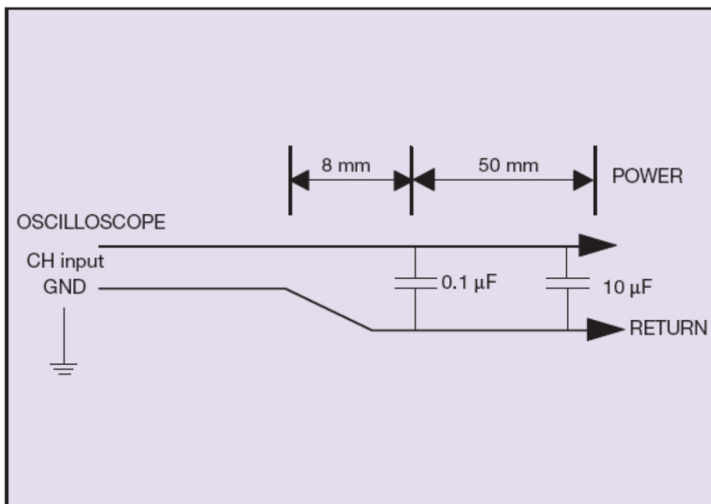
All power supply outputs will be designed for redundant mode operation. No internal failure in any power supply in this configuration should cause the bus voltage to fall below the regulation limits specified. All output voltages should stay within the regulation limits during cold swapping or hot swapping operation.



APPLICATION NOTES

Output Ripple and Noise Measurement

The setup outlined in the diagram below has been used for output voltage ripple and noise measurements on the DS2000SPE-3 series. When measuring output ripple and noise, a scope jack in parallel with a 0.1 μ F ceramic chip capacitor, and a 10 μ F tantalum capacitor will be used. Oscilloscope can be set to 20MHz bandwidth for this measurement.



RECORD OF REVISION AND CHANGES

Issue	Date	Description	Originators
1.1	12.12.2016	Remove Class A +6db margin Change minimum current to 5A for transient load response testing only Change main output minimum capacitive load from 3900uF to 4900uF	S. Dong
1.2	11.07.2017	Update device address, output regulation, system timing, altitude	S. Dong
1.3	02.27.2018	Update default device address	S. Dong
1.4	05.16.2018	Remove "FRU address" columns	K. Wang
1.5	03.04.2021	Update cover and back cover	C. Liu



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PRECISION | POWER | PERFORMANCE

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