PS1000 and PL1000

1000 Watts
High Availability Power Supply Units

Total Power: 1000 W
Input Voltage: 180-264 Vac (single phase)
311-428 Vac (3 Phase)
Main Output: 12.25 Vdc

Special Features

- Fault mode resiliency
- Dynamic maximum input power limit (DMIPL)
- AC feed failure, automatic switchover
- Inrush current control
- N+1 internal redundant
- PMBus® compliant
- EMC Conducted/Radiated Class A
- EMC EN/IEC 61000
- RoHS

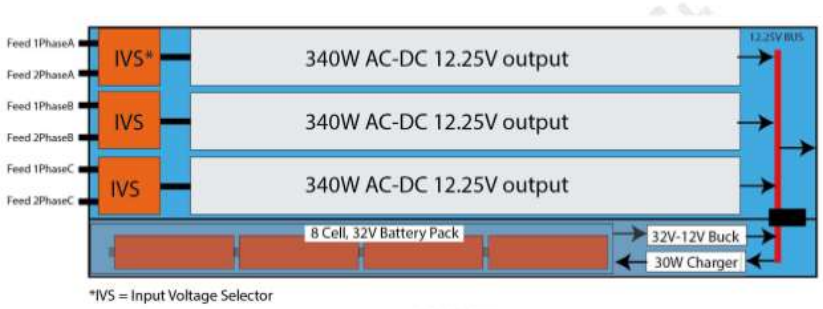
Safety

UL/CSA 60950 (UL recognized)
IEC 60950
CE Mark

Product Descriptions

The PS1000 and PL1000 are high availability server power supply unit (PSU) developed for hyperscale cloud deployments. The PL1000 PSU is also available with an embedded battery backup unit (BBU). The PS1000 and PL1000 were designed to support an open source hardware development effort through Open Compute Project (OCP) collaboration. The PS1000 and PL1000 support a new standard building block model for OCP solution providers to develop hardware solutions from a common design.

The power supply is a dual three phase input and 1000W output. The system consists of an IVS section receiving dual inputs of three single phases (6 total) and three 340W power supply modules (PSM's) in parallel with a total maximum output of 1000W. Each PSM will be powered off one of the three IVS outputs. The power supply load/output will not be hot pluggable but AC input will. There will be an optional battery that will be contained in the PSU chassis. Failure of a single PSM or loss of a single phase will not affect system operation for loads 680W and below. Power supply inputs will be hot swappable. Outputs will not be hot swapped. 2 PSM's fail and total load is equal to or less than 340W the remaining module should continue to operate.



PSU Block Diagram

ARTESYN™
An Advanced Energy Company

Model Numbers

Standard	Output Voltage	Minimum Load	Maximum Load	With Batteries
PL1000	12.25Vdc	0A	81.5 A	Y
PS1000	12.25Vdc	0A	81.5 A	N

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	Model	Symbol	Min	Typ	Max	Unit
Input Voltage Dual inputs of three single phases (6 total) Single phase WYE Delta	All models	$V_{IN,AC}$	 180 311 187	 - - -	 264 457 228	Vac
Maximum Output Power V_{IN} =200Vac	All models	$P_{O,max}$	-	-	1160	W
Isolation Voltage Input to outputs Input to safety ground	 All models All models		 - -	 - -	 2121 2121	 Vdc Vdc
Ambient Operating Temperature	All models	T_A	+10	-	+48	ºC
Storage Temperature	All models	T_{STG}	-40	-	+60	ºC
Humidity (non-condensing) Operating Non-operating	 All models All models		 10 5	 - -	 90 95	 % %
Altitude Operating Non-operating	All models All models All models All models		- - - -	- - - -	10,000 (3050) 30,000 (9144)	Feet M Feet M

Input Specifications

Table 2. Input Specifications:

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, AC Single phase 3 phase - WYE 3 phase - Delta		$V_{IN,AC}$	 180 311 187	 230 400/415 208	 264 457 228	 Vac Vac Vac
Input AC Frequency		$f_{IN,AC}$	47	50/60	63	Hz
Maximum Input Current for each 340W module $I_O = I_{O,max}$	$V_{IN,AC} = V_{IN,min}$	$I_{IN,max}$	-	-	2.4	A
No Load Input Current (V_O =On, I_O = 0A,)	PL1000 PS1000	$I_{IN,no-load}$	- -	- -	300 400	mA mA
Harmonic Line Currents	All	THD	Per IEC1000-3-2			
Input iTHD	I_O = 5 to 15%$I_{O,max}$ I_O = 15 to 30%$I_{O,max}$ I_O = 30 to 100%$I_{O,max}$		- - -	- - -	20 10 5	% % %
Power Factor	$V_{IN,AC}$ = 240Vac $I_O = I_{O,\ max}$		0.98	-	-	
Startup Surge Current (Inrush) for each 340W module	All	$I_{IN,surge}$	-	-	9	A
Input Fuse	Internal, L and N 2410,CERAMIC, Quick Acting 4A, 250V		-	4	-	A
Leakage Current to earth ground for each 340W module	$V_{IN,AC}$ = 240Vac $f_{IN,AC}$ = 50/60 Hz		-	-	3.5	mA
Operating Efficiency @ 25^{O}C	I_O = 50%$I_{O,max}$ $V_{IN,AC}$ = 200Vac $V_{IN,AC}$ = 208Vac $V_{IN,AC}$ = 230Vac $V_{IN,AC}$ = 240Vac	η	 93 94 94 94	 - - - -	 - - - -	 % % % %
System Stability Phase Margin Gain Margin			 45 -10	 - -	 - -	 Ø dB

Output Specifications

Table 3. Output Specifications:

Parameter		Condition	Symbol	Min	Typ	Max	Unit
Output Setpoint	On AC Mains	I_O = 0 I_O = 40A I_O = 80A	V_O	12.17 12.05 11.93	12.37 12.25 12.13	12.57 12.45 12.33	V
	On Battery	I_O = 0 I_O = 27A I_O = 55A	V_O	12.17 12.089 12.005	12.37 12.289 12.205	12.57 12.489 12.405	V
Output Regulation	All models	Inclusive of set-point, all load and line voltages across the ambient temperature limits under steady state conditions	V_O	12.00	12.25	12.50	Vrms
Output Ripple, pk-pk	All models	Measure with a 0.1µF ceramic capacitor in parallel with a 10µF tantalum capacitor, 0 to 20MHz bandwidth	V_O	-	-	120	mV_{PK-PK}
Common Mode Noise	All models	10Hz to 20Hz bandwidth The measurement will be made across a 100Ω resistor between each of DC outputs	V_O	-	-	350	mV_{PK-PK}
Output Current	N (3 modules) N+1(2 modules)	All	I_O	1 0	- -	81.5 56.0	A A
Load Capacitance		Start up		200	-	5000	µF
V_O Dynamic Response Peak Deviation		60% load change, 1% to 60% load C_O =3500uF +/-5% slew rate = 0.25A/us	V_O	11.7	-	12.8	V
V_O Long Term Stability Max change over 24 hours		After thermal equilibrium (30 mins)	±%V_O			0.2	%

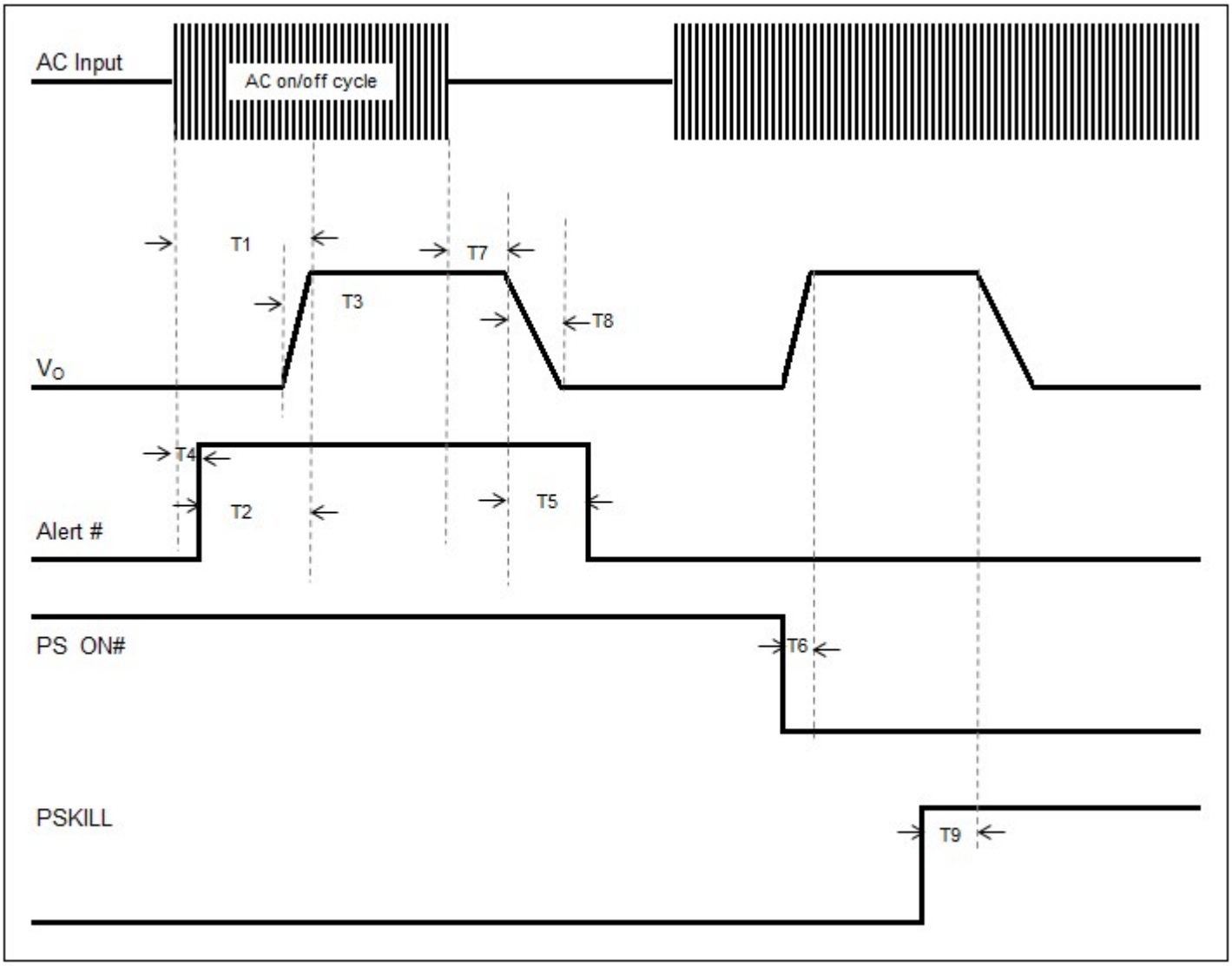
System Timing Specifications

Table 4. System Timing Specifications:

Label	Parameter	Min	Typ	Max	Unit
T1	Delay from AC being applied to V_O output voltage being within regulation	500	1000	3000	mSec
T2	Delay from Alert to V_O output voltages being within regulation	-	100	-	mSec
T3	V_O rise time, 0V to V_O in regulation.	40	45	50	mSec
T4	Delay from AC being applied to Alert asserted high.	-	TBD	-	mSec
T5	Delay from Vo stay within regulation to Alert going to low	-	TBD	-	mSec
T6	Delay from PS_ON# active to output voltages within regulation limits.	80	100	120	mSec
T7	Hold up time - time output voltage stay within regulation after loss of AC.	20	-	-	mSec
T8	V_O fall time, V_O in regulation to 0V	-	60	-	mSec
T9	Delay from PS_KILL to V_O stay within regulation for PS1000 Delay from PS_KILL to V_O stay within regulation for PL1000	- -	5 200	- -	mSec

System Timing Specifications

Figure 1. System Timing Diagram:

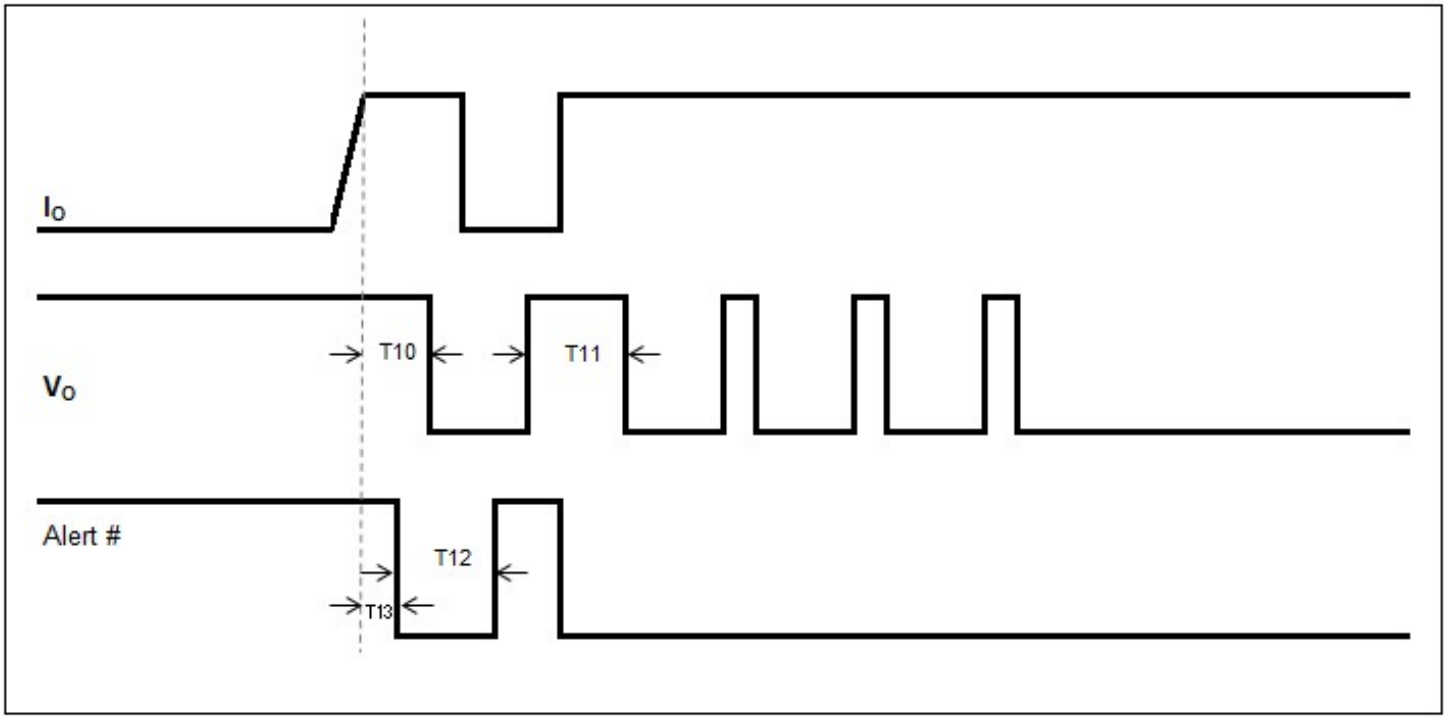


System Timing Specifications

Table 5. OCP Timing Specifications:

Label	Parameter	Min	Typ	Max	Unit
T10	OCP delay time	-	200	-	mSec
T11	OCP Turn off 2 seconds	-	2000	-	mSec
T12	Until clear fault command is received	20	-	-	mSec
T13	Alert signal assert once OCP threshold reached	-	-	5	mSec

Figure 2. OCP Timing Specifications

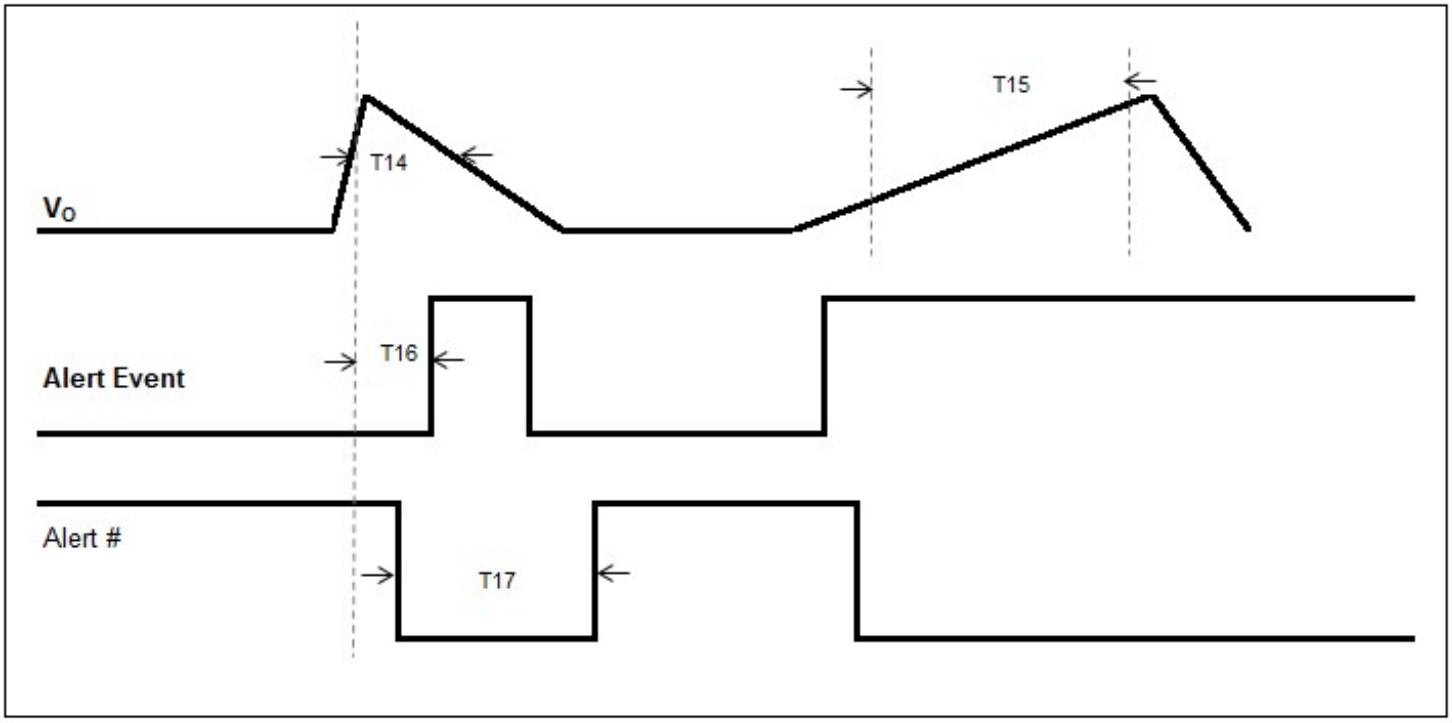


System Timing Specifications

Table 6. OVP Timing Specifications:

Label	Parameter	Min	Typ	Max	Unit
T14	OVP latch time	-	-	15	mSec
T15	12V Shuts off and latched PSON/AC cycle to reset	15	-	-	mSec
T16	Reached threshold Alert assert	5	-	-	mSec
T17	Until clear fault command is received	20	-	-	mSec

Figure 3. OVP Timing Specifications



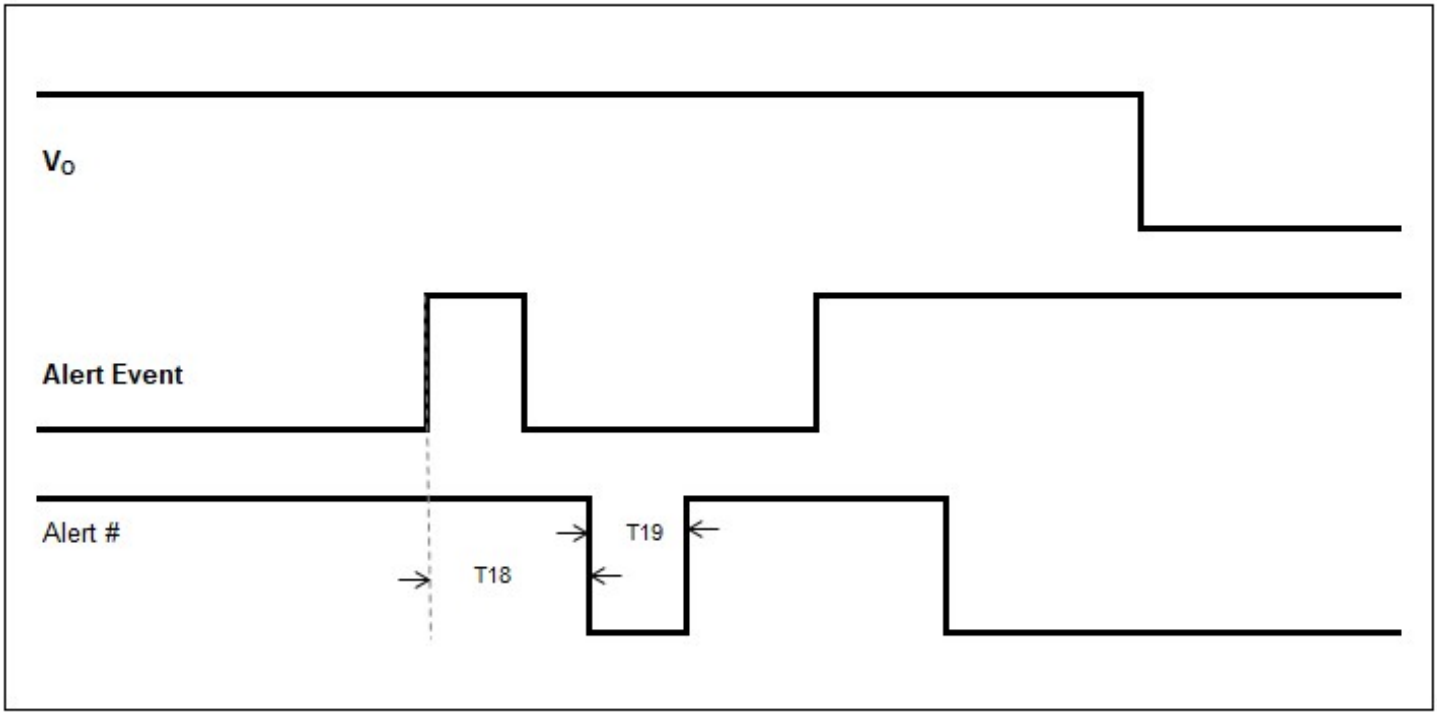
System Timing Specifications

Table 7. Alert Event Timing Specifications:

Label	Parameter	Min	Typ	Max	Unit
T18	Delay from Alert Event to Alert signal assert	-	-	10[1]	mSec
T19	Until clear fault command is received	20	-	-	mSec

Note 1: 5 mS for STATUS_Iout

Figure 4. Alert Event Timing Specifications



Alert Event and masking/unmasking
Status_Vout (0x7A): 0XFF(1111 1111)
Status_Iout (0x7B):0x5F(0101 0000)
Status_Input(0x7C):0xFF(1111 1111)
Status_Temperature(0x7D): 0xFF(1111 1111)
Status_CML(0x7E): 0xFF(1111 1111)

PL1000 Performance Curves

Figure 5: PL1000 Turn-on delay via AC mains – V_{IN} = 180Vac

Ch 1: AC Mains Ch 2: V_o Ch 3: PSU_Alert

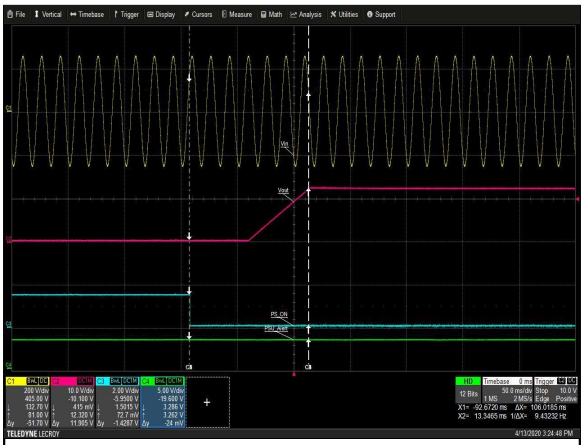


Figure 6: PL1000 Turn-on delay via PS_ON – V_{IN} = 180Vac

Ch 1: AC Mains Ch 2: V_O Ch 3: PS_ON Ch 4: PSU_Alert

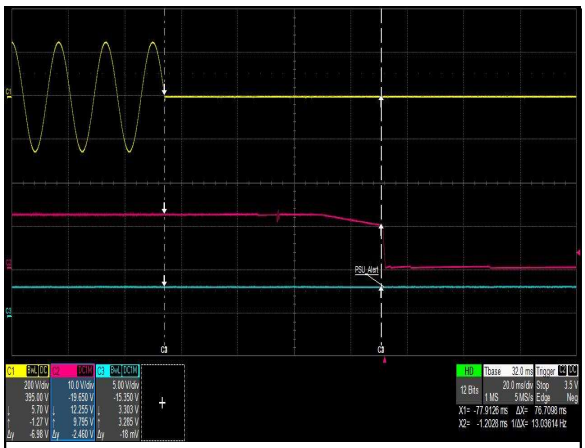


Figure 7: PL1000 Hold-up Time – V_{IN} = 180Vac / 60Hz / 0°
Full Load: I_O = 55A

Ch 1: AC Mains Ch 2: V_O Ch 3: PSU_Alert

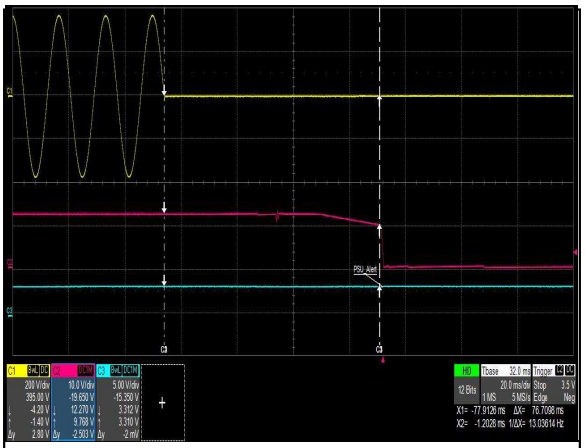


Figure 8: PL1000 Hold-up time – V_{IN} = 264Vac / 60Hz / 0°
Full Load: I_O = 55A

Ch 1: AC Mains Ch 2: V_O Ch 3: PSU_Alert

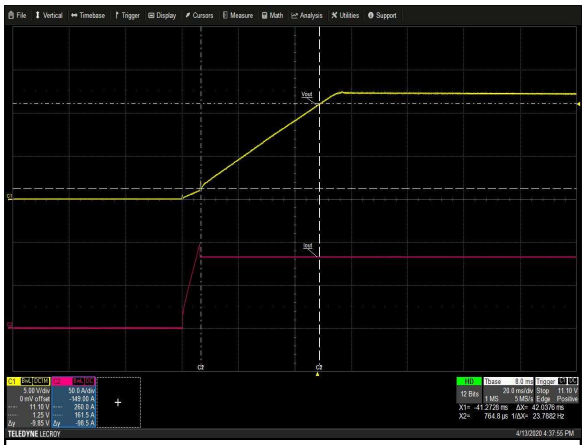


Figure 9: PL1000 Output Voltage Startup Characteristic – V_{IN}= 180Vac
Full Load: I_O = 80A

Ch 1: V_O Ch 2: PSU_Alert

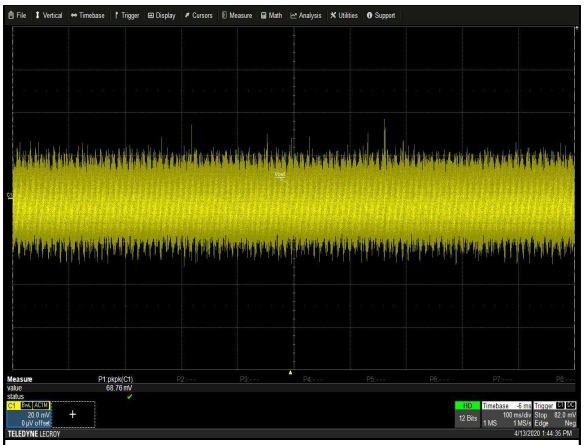


Figure 10: PL1000 Ripple and Noise Measurement – V_{IN} = 180Vac
Full Load: I_O = 80A

Ch 1: V_O

PL1000 Performance Curves

Figure 11: PL1000 Turn Off Characteristic via PS_ON
Full Load: I_O = 80A
Ch 1: V_O Ch 2: PSU_Alert Ch 3: PS_ON

Figure 12: PL1000 Turn Off Characteristic via PS_Kill
Full Load: I_O = 80A
Ch 1: PS_Kill Ch 2: V_O Ch 3: PSU_Alert

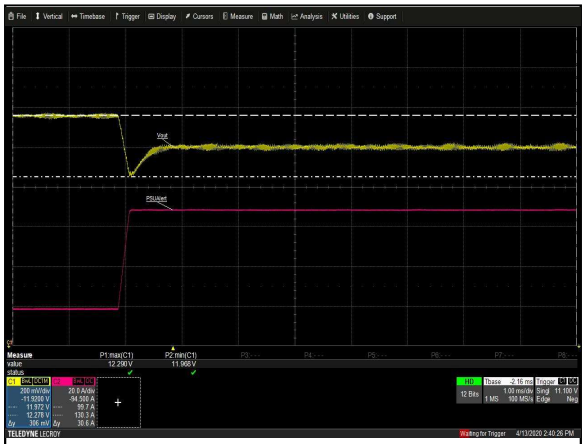


Figure 13: PL1000 Transient Response – Vo Deviation (low to high)
40% to 100% load change, 0.25A/µS slew rate, V_{IN} = 230Vac
Ch 1: V_O Ch 2: I_O

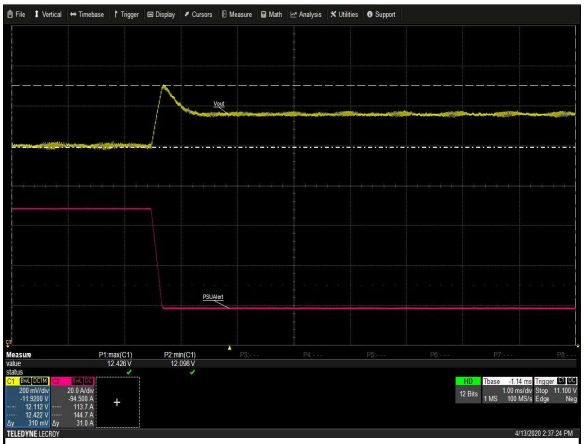


Figure 14: PL1000 Transient Response – Vo Deviation (high to low)
40% to 100% load change, 0.25A/µS slew rate, V_{IN} = 230Vac
Ch 1: V_O Ch 2: I_O

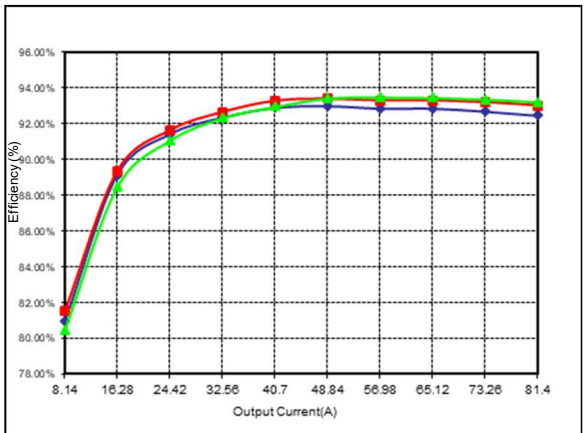


Figure 15: PL1000 Efficiency Curves @ 25 degC
----- 180Vac ----- 230 Vac ----- 264 Vac
Loading: I_O = 10% to 100% load

PS1000 Performance Curves

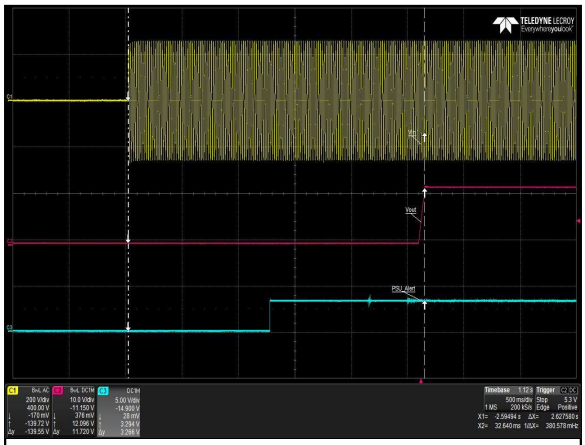


Figure 16: PS1000 Turn-on delay via AC mains – V_{IN} = 180Vac

Ch 1: AC Mains Ch 2: V_O Ch 3: PSU_Alert

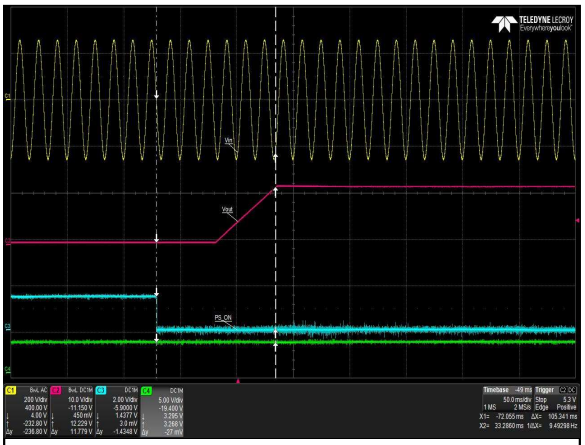


Figure 17: PS1000 Turn-on delay via PS_ON – V_{IN} = 180Vac

Ch 1: AC Mains Ch 2: PS_ON Ch 3: V_O Ch 4: PSU_Alert

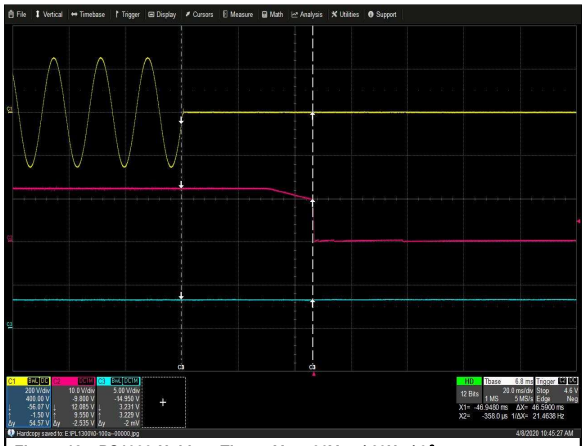


Figure 18: PS1000 Hold-up Time – V_{IN} = 90Vac / 60Hz / 0°
Full Load: I_O = 80A,

Ch 1: AC Mains Ch 2: V_O Ch 3: PSU_Alert

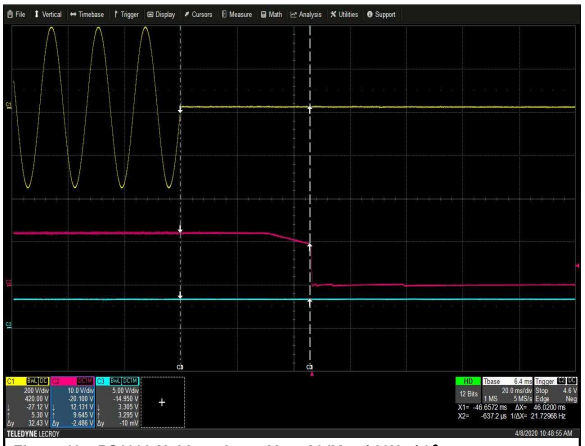


Figure 19: PS1000 Hold-up time – V_{IN} = 264Vac / 60Hz / 0°
Full Load: I_O = 80A

Ch 1: AC Mains Ch 2: V_O Ch 3: PSU_Alert

Figure 20: PS1000 Output Voltage Startup Characteristic – V_{IN}= 180Vac
Full Load: I_O = 80A

Ch 1: V_O Ch 2: I_O

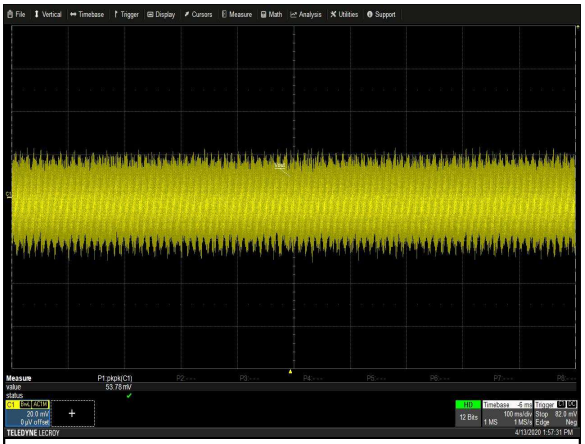


Figure 21: PS1000 Ripple and Noise Measurement – V_{IN} = 230Vac
Full Load: I_O = 80A

Ch 1: V_O

PS1000 Performance Curves

Figure 22: PS1000 Turn Off Characteristic via PS_ON
Full Load: I_O = 80A
Ch 1: PS_ON Ch 2: V_O Ch 3: PSU_Alert

Figure 23: PS1000 Turn Off Characteristic via PS_Kill
Full Load: I_O = 80A
Ch 1: PS_INHIBIT Ch 2: V_O Ch 3: PSU_Alert

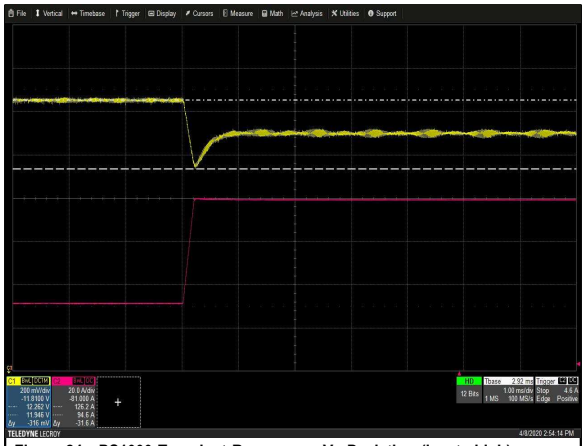


Figure 24: PS1000 Transient Response – Vo Deviation (low to high)
40% to 100% load change, 0.2A/µS slew rate, V_{IN} = 230Vac
Ch 1: V_O Ch 2: I_O

Figure 25: PS1000 Transient Response – Vo Deviation (high to low)
100% to 40% load change, 0.2A/µS slew rate, V_{IN} = 230Vac
Ch 1: V_O Ch 2: I_O

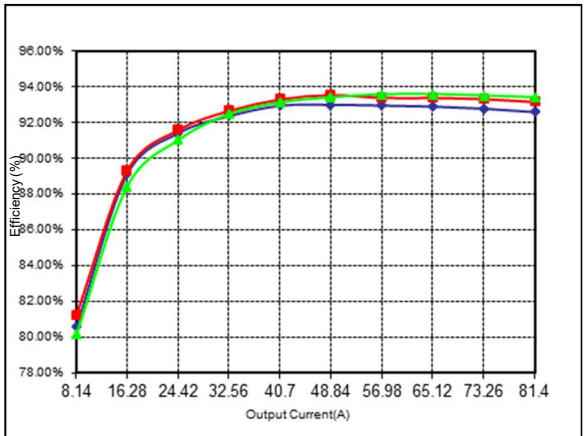


Figure 26: PS1000 Efficiency Curves @ 25 degC
----- 180Vac ----- 230 Vac ----- 264 Vac
Loading: I_O = 10% to 100% load

Protection Function Specification

Input Fusing

PS1000 and PL1000 series are equipped with an internal non user serviceable 4A fast acting 250 Vac fuse for fault protection in both the L1 and L2 lines input.

Battery Recharge Protection

The battery recharge can be limited to 30W or higher and is a function of Input Power Limit (IPL) set point. If the IPL is activated the battery recharge will be disabled.

Battery Discharge Protection

If at any time during discharge the state of charge of any battery cell drops to a level equal to the minimum voltage allowed by the manufacturer, the 12V output will be disabled immediately to prevent battery damage.

Over Voltage Protection (OVP)

The power supply over voltage protection should be shut down in a latch off mode upon an over voltage condition.

OVP

Parameter	Min	Nom	Max	Unit
V_O Output Over Voltage	13.6	/	15.0	V

Over Current Protection (OCP)

The power supply can provide limited output current to the load for protecting the power supply from damage under indefinite over load conditions. OCP point is set between 115% and 130% of rated output current. Under an overcurrent condition for over 200ms, the power supply will employ hiccup mode (200ms on and 2 seconds off) for 5 cycles and if overcurrent isn't cleared after the 5th cycle, the power supply will latch off (All timing accuracy above is +/- 20%). Over current events under 100ms will be ignored.

Parameter	Min	Nom	Max	Unit
V_O Output Over Current	115	/	130	$\%I_{O,max}$

Short Circuit Protection (SCP)

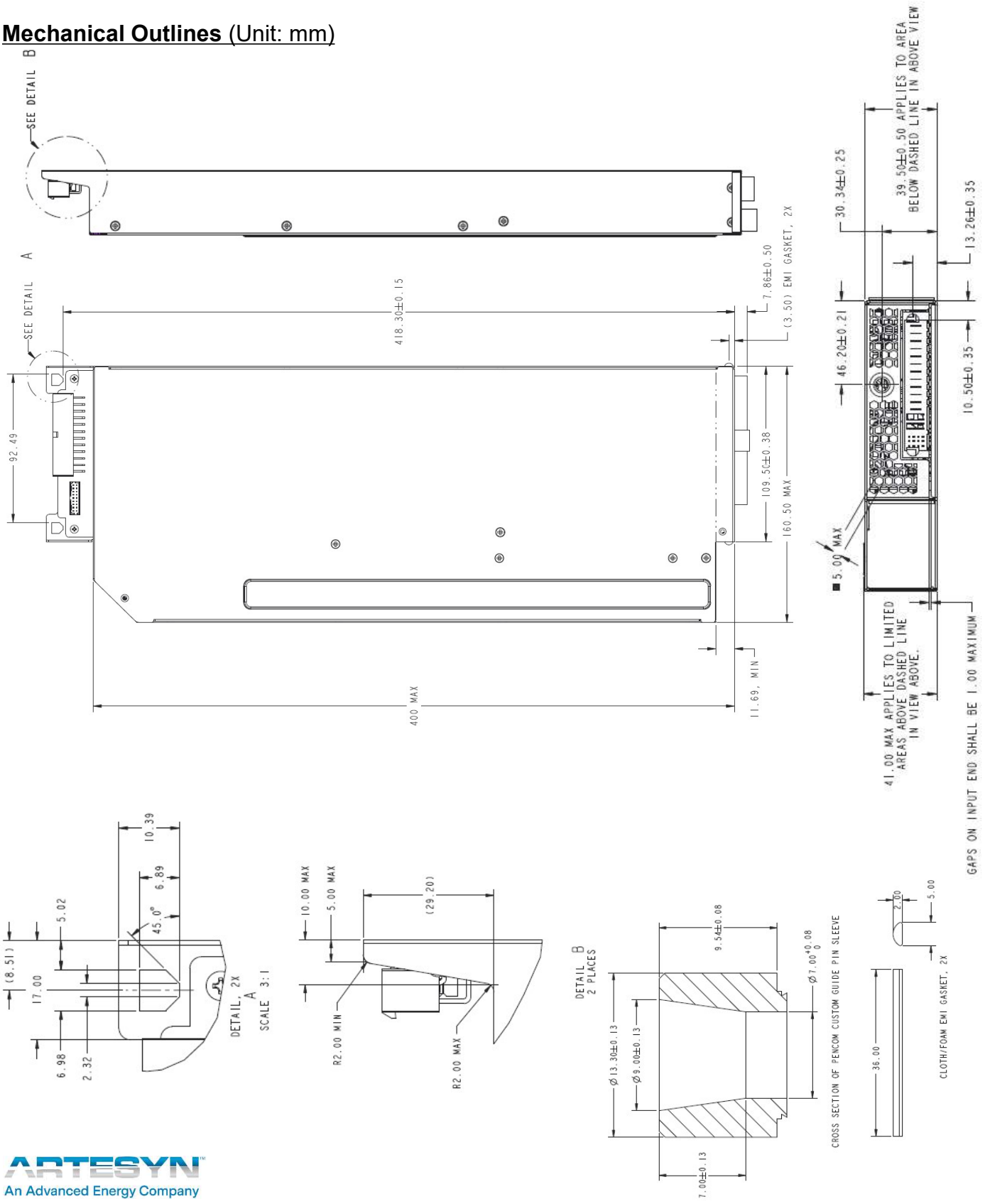
For short circuit situations, the power supply will latch off immediately to prevent damage.

Over Temperature Protection (OTP)

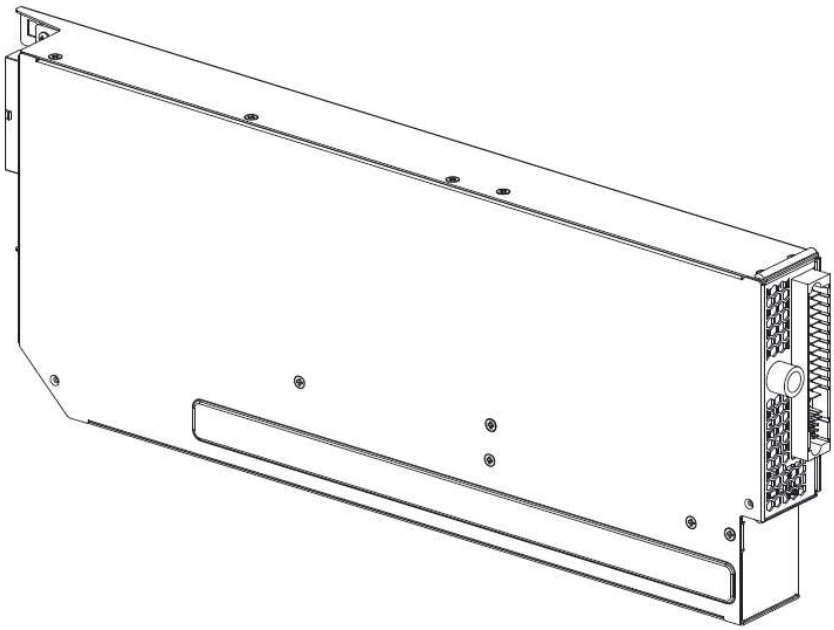
The power supply can be protected against over temperature conditions caused by loss of fan cooling or excessive ambient temperature which could cause internal part failures. In an over temperature condition the power supply will shutdown protecting itself. When the temperature drops to within safe operating limit for internal parts, the power supply will restore power automatically. The OTP circuit is incorporate built in hysteresis such that the power supply does not oscillate on and off due to temperature recovering condition. The OTP event will be reported as a fault condition.

Mechanical Specifications

Mechanical Outlines (Unit: mm)



Mechanical Outlines

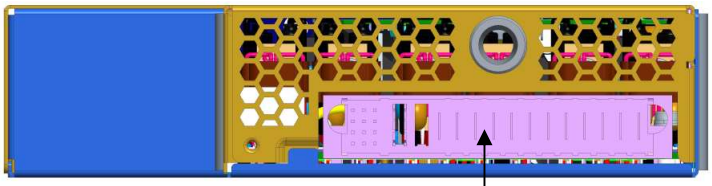


Connector Definitions

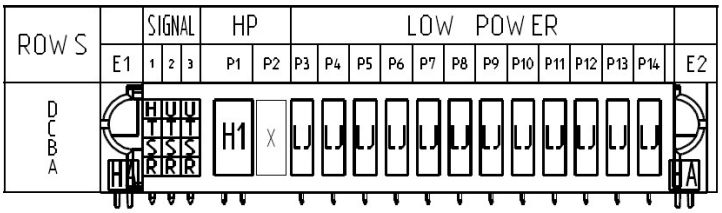
Table 8. AC Input Connector

Pin Number	Description	
	WYE	Delta
Pin 1	Safety Ground	Safety Ground
Pin 2	Not Used	Not Used
Pin 3	Backup Feed - Neutral	Backup Feed - Phase A
Pin 4	Backup Feed - Phase C	Backup Feed - Phase C
Pin 5	Default Feed - Neutral	Default Feed - Phase A
Pin 6	Default Feed - Phase C	Default Feed - Phase C
Pin 7	Backup Feed - Neutral	Backup Feed - Phase C
Pin 8	Backup Feed - Phase B	Backup Feed - Phase B
Pin 9	Default Feed - Neutral	Default Feed - Phase C
Pin 10	Default Feed - Phase B	Default Feed - Phase B
Pin 11	Backup Feed - Neutral	Backup Feed - Phase B
Pin 12	Backup Feed - Phase A	Backup Feed - Phase A
Pin 13	Default Feed - Neutral	Default Feed - Phase B
Pin 14	Default Feed - Phase A	Default Feed - Phase A
Pin A1	LR_SELECT	
Pin A2	NODE_ID0	
Pin A3	Analog Return	
Pin B1	NODE_ID1	
Pin B2	NODE_ID2	
Pin B3	NODE_ID3	
Pin C1	BLADE_THROTTLE#	
Pin C2	BLADE_ENABLE#	
Pin C3	BLADE_PRESENT#	
Pin D1	PSKILL(Short Pin)	
Pin D2	NODE_ID4	
Pin D3	NODE_ID5	

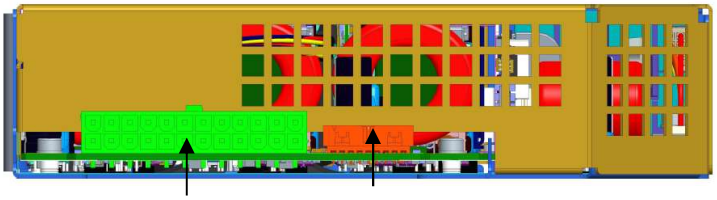
Front View



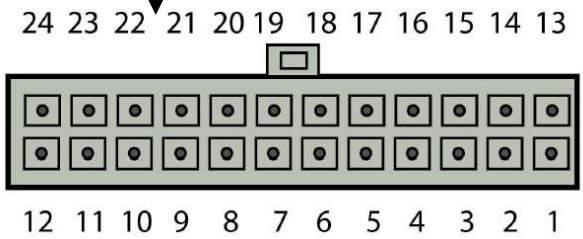
AC inlet connector



Rear Panel



Output Power Blades Control signal



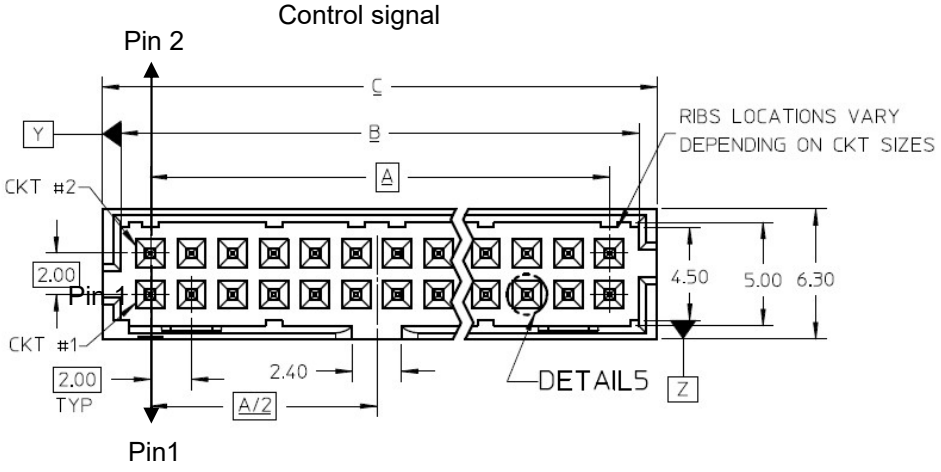
Output Connector – Power Blades

Pin 1 ~ Pin 6 – + Main Output (V_O)
Pin 7 ~ Pin 12 – Main Output Return
Pin 13 ~ Pin 18 – + Main Output (V_O)
Pin 19 ~ Pin 24 – Main Output Return

Output Connector – Control Signals

Pin 1 – BLADE_ENABLE#
Pin 2 – LR_SELECT
Pin 3 – NODE_ID0
Pin 4 – NODE_ID1
Pin 5 – BLADE_THROTTLE#
Pin 6 – BLADE_PRESENT#
Pin 7 – I2C_SCL
Pin 8 – I2C_SDA
Pin 9 – I2C_GND
Pin 10 – PS_ON#
Pin 11 – PSU_ALERT#
Pin 12 – PSU_LED0
Pin 13 – PSU_LED1
Pin 14 – NODE_ID2
Pin 15 – NODE_ID3
Pin 16 – NODE_ID4
Pin 17 – NODE_ID5
Pin 18 – Reserved

Control signal



Power / Signal Mating Connectors and Pin Types

Table 9. Mating Connectors for PL1000/PS1000 series

Reference	On Power Supply	Mating Connector or Equivalent
AC Input Connector	FCI Power Blade 10106262-IC03002C or 10106262-IC03004C	FCI 10106265-1C03001LF
Output Power Connector	24 pin molex minfit junior 469911024 or equivalent	Housing : Molex 0469922410 Pin: Molex 0039000060
Output Signal Connector	18 pin molex milligrid series connector 878311828 or equivalent.	Molex 79107-7008

LED indicator Definition

The PSU have 2 signals that will drive a 1 dual color LED mounted on the system chassis. LED ON will be 3.3V applied to the LED drive through 150 ohms or less. LED OFF will be the LED drive signal pulled to ground through 150 ohms or less. A FET switch is preferred to eliminate the Collector emitter voltage drop. Following are the LED drivers and power supply LED States.

Power Supply LED States:

Condition	LED Status
AC_OK & DC_OK (Power Good)	Solid Green
Fault of any kind	Solid Yellow
Internal Battery Charging	Blinking Green at 2 Hz
Operating off internal battery	Blinking Yellow at 2 Hz
One of two AC Feeds has failed	Blinking Yellow-Green-Yellow at 2Hz

Weight

The PS1000 weight is 6 lbs 0oz maximum without battery;

The PL1000 weight is 7 lbs 6oz maximum with a battery installed.

Environmental Specifications

EMC Immunity

PS1000 and PL1000 series power supply is designed to meet the following EMC immunity specifications:

Table 10. Environmental Specifications:

Document	Description
FCC/ICES-003	Emissions (USA/Canada) Verification
CISPR 32	Emissions (International) and CISPR 24 (Immunity)
EN61000-3-2	Harmonics
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 C.
IEC/EN61000-4-3	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Radiated RFI immunity, 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, 1.0KV for DC ports, I/O and signal ports performance Criteria B.
IEC/EN61000-4-5	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - 2KV common mode and 1KV differential mode for AC ports and 0.5kV differential mode for DC power, I/O and signal ports, performance criteria B.
IEC/EN61000-4-6	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - RF conducted.
IEC/EN61000-4-8	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Power Frequency Magnetic Fields.
IEC/EN61000-4-11	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Voltage Dips and Interruptions.
EN55024	Information Technology Equipment-Immunity Characteristics, Limits and Method of Measurements
EN55032	Emissions (Europe)
VCCI	Electromagnetic Compatibility (EMC) - Japan
KN 32 and KN35	Electromagnetic Compatibility (EMC) - South Korea

Safety Certifications

The PS1000 and PL1000 power supplies are 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 11. Safety Certifications for PS1000 and PL1000 series power supply system

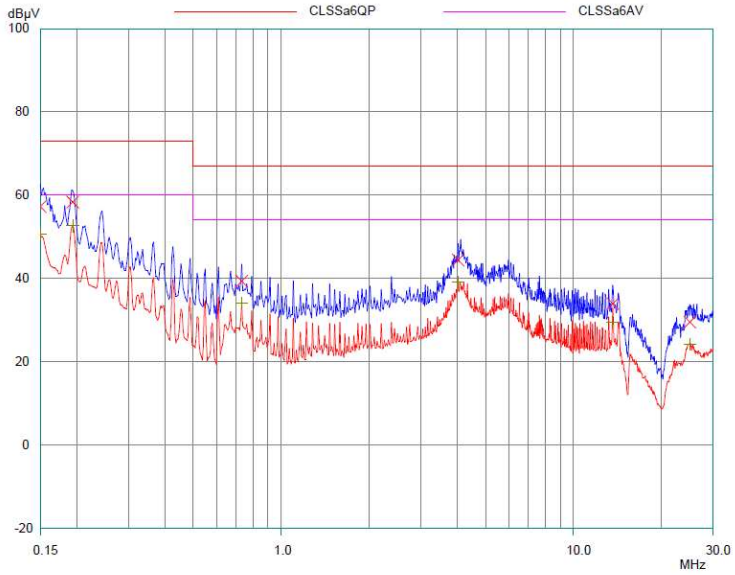
Document	Description
UL/CSA 60950-1 and UL/CSA 62368-1	US and Canada Requirements
EN60950-1 and EN 62368-1	European Requirements
IEC60950-1 and IEC 62368-1	International Requirements
CB Certificate and Report	(All CENELEC Countries)
GB4943.1- CNCA Certification	China Requirements

EMI Emissions

The PS1000 and PL1000 series 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 (IEC 61000) for immunity. The unit is enclosed inside a metal box, tested at 1000W using resistive load with cooling fan.

Conducted Emissions

The applicable standard for conducted emissions is EN55032 (FCC/ICES-003) 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 PL1000 and PS1000 series power supplies have internal EMI filters to ensure the convertors' conducted EMI levels comply with EN55032 (FCC/ICES-003) Class A and EN55032 (CISPR 32) Class A limits. The EMI measurements are performed with resistive loads at maximum rated loading.

Sample of EN55032 Conducted EMI Measurement at 208Vac input

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

Table 12. Conducted EMI emission specifications of the PS1000 PL1000 series

Parameter	Model	Symbol	Min	Typ	Max	Unit
FCC/ICES-003, class A	All	Margin	6	-	-	dB
CISPR 32 (EN55032) 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 EN55032 (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 leads to be attached to the input, and any auxiliary output cables 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 PS1000 and PL1000 series power supplies will start and operate within stated specifications at an ambient temperature from 10 ^{O}C to 43 ^{O}C under all load conditions with internal fan. 20 ^{O}C to 43 ^{O}C for Battery. Allowable derating guideline of 1 ^{O}C F / 550 ft (0.55 ^{O}C / 168 m) above 3000 feet .

Forced Air Cooling

The power supplies have at least 2 internal fans with fan speed control. The Fans will operate at the minimum speed needed to keep all components within the thermal derating levels for all loading and ambient conditions. Under fan fail condition the remaining fan(s) can be set to maximum speed. Upon loss of all fans the PSU should operate until overtemp is reached and then will latch off.

Backflow prevention: In addition to varying the fan speed for protecting the internal components, the PSU will also monitor inlet air temperature and if inlet temperature goes above 45 ^{O}C, fan speed will increase to keep inlet air temperature at 45 ^{O}C or below.

The PSU will monitor critical temperatures and adjust fan speed to prevent thermal damage but run a slow as possible to save energy. Note that two or more fans are required. The power supply will be able to run indefinitely with one fan failure at 680W or below. Reliability and derating requirements do not have to be met while operating on one fan. Fans can be set to maximum speed during a fan fail event. Note also that cooling for the whole PSU must depend on internal fans only and cannot rely on any help from system fans. Also, note that sheet metal on the battery side of PSU can have ambient air adjacent outside the PSU in the blade up to 60 ^{O}C. It is recommended that some PSU airflow be directed between the battery and the chassis in this area to keep the battery cool.

Storage and Shipping Temperature / Humidity

The PS1000 and PL1000 series power supplies can be stored or shipped at temperatures between –40 ^{O}C to +60 ^{O}C and relative humidity from 5% to 95% non-condensing.

Altitude

The PS1000 and PL1000 series will operate within specifications at altitudes up to 10,000 feet (3050m) above sea level. The power supply will not be damaged when stored at altitudes of up to 30,000 feet (9144m) above sea level.

Humidity

The PS1000 and PL1000 series will operate within specifications when subjected to a relative humidity from 10% to 90% non-condensing. The PS1000 and PL1000 series can be stored in a relative humidity from 5% to 95% non-condensing.

Vibration

The PS1000 and PL1000 power supply will pass the following vibration specifications:

Non-Operating Random Vibration

Acceleration	2.0		gRMS
Frequency Range	10-500		Hz
Duration	60		mins
Direction	3 mutually perpendicular axis		
PSD Profile	**FREQ** 10-500 Hz	**SLOPE** **dB/oct** ---	**PSD** **g^2/Hz** 0.008 g^2/Hz

Operating Random Vibration

Acceleration	1.0		gRMS
Frequency Range	10-500		Hz
Duration	60		mins
Direction	3 mutually perpendicular axis		
PSD Profile	**FREQ** 10-500 Hz	**SLOPE** **dB/oct** ---	**PSD** **g^2/Hz** 0.002 g^2/Hz

Shock

The PS1000 and PL1000 series power supply will pass the following vibration specifications:

Non-Operating Half-Sine Shock

Acceleration	140	G
Duration	2	msec
Pulse	Half-Sine	
No. of Shock	3 shock on each of 6 faces	

Operating Half-Sine Shock

Acceleration	5	G
Duration	11	msec
Pulse	Half-Sine	
No. of Shock	3 shock on each of 6 faces	

Power and Control Signal Descriptions

AC Input Connector

AC inlet connector is an FCI Power Blade 12S+1P+12LP part number 10106262-IC03002C or 10106262-IC03004C or similar competitor's connector.

Pin Number	Description	
	WYE	Delta
P1	Safety Ground	Safety Ground
P2	Not Used	Not Used
P3	Backup Feed Neutral	Backup Feed Phase A
P4	Backup Feed Phase C	Backup Feed Phase C
P5	Default Feed Neutral	Default Feed Phase A
P6	Default Feed Phase C	Default Feed Phase C
P7	Backup Feed Neutral	Backup Feed Phase C
P8	Backup Feed Phase B	Backup Feed Phase B
P9	Default Feed Neutral	Default Feed Phase C
P10	Default Feed Phase B	Default Feed Phase B
P11	Backup Feed Neutral	Backup Feed Phase B
P12	Backup Feed Phase A	Backup Feed Phase A
P13	Default Feed Neutral	Default Feed Phase B
P14	Default Feed Phase A	Default Feed Phase A
A1	LR_SELECT	
A2	NODE_ID0	
A3	Analog Return	
B1	NODE_ID1	
B2	NODE_ID2	
B3	NODE_ID3	
C1	BLADE_THROTTLE#	
C2	BLADE_ENABLE#	
C3	BLADE_PRESENT#	
D1	PSKILL (Short Pin)	
D2	NODE_ID4	
D3	NODE_ID5	

Output Power Connector

The output power connector is a 24 pin Molex minifit junior 469911024 or equivalent.

PSU Pin		Power
1	13	12V
2	14	12V
3	15	12V
4	16	12V
5	17	12V
6	18	12V
7	19	Return
8	20	Return
9	21	Return
10	22	Return
11	23	Return
12	24	Return

Output Signal Connector

The output signal connector is a 18 pin Molex milligrid series connector 878311828 or equivalent.

Pin Number	Signal Name	Note
1	BLADE_ENABLE#	Pass through from PMDU
2	LR_SELECT	Pass through from PMDU
3	NODE_ID0	Pass through from PMDU
4	NODE_ID1	Pass through from PMDU
5	BLADE_THROTTLE#	Pass through from PMDU
6	BLADE_PRESENT#	Pass through from PMDU
7	I2C_SCL	Pass through from PMDU
8	I2C_SDA	Pass through from PMDU
9	I2C_GND	Pass through from PMDU
10	PS_ON#	/
11	PSU_ALERT#	/
12	PSU_LED0	Green LED
13	PSU_LED1	Yellow LED
14	NODE_ID2	Pass through from PMDU
15	NODE_ID3	Pass through from PMDU
16	NODE_ID4	Pass through from PMDU
17	NODE_ID5	Pass through from PMDU
18	Reserved	No Connection

BLADE_PRESENT# - (pin 6)

This signal will be pulled up to 3.3V through a 100K ohm resistor. It will be pulled low in the compute blade.

PS_KILL - (pin D1)

For PS1000 power supply, the power supply will default to 12V being disabled between 180ms and 200ms of PS_KILL going high. For PL1000 power supply, PS_KILL will be ignored or operational per the Software Interface spec. The recommended pull up resistor is 10K ohm.

Signal name	Input/ output to PSU	Open collector	3V3 logic	Signal pull up resistor value (Ohm)	Logic low max (V)	Logic high min (V)	Sink/ source current max (mA)	Rise time max (usec)	Fall time max (usec)	Cmax external to PSU (pF)	Peak noise (mVpk-pk)
PS_KILL	In	No	Yes	10K	0.4	2.0V or NC	0.5	250	2.5	0	250

PS_ON# - (pin 10)

The PSU will be ON when PS_ON# is pulled low below 0.8Vdc. PS_ON# will be 3.3V or 5V tolerant. Note that toggling of PS_ON# will reset latched faults but not clear fault registers. The recommended pull up resistor is 49.9K ohm.

Signal name	Input/ output to PSU	Open collector	3V3 or 5V logic	Signal pull up resistor value (Ohm)	Logic low max (V)	Logic high min (V)	Sink/ source current max	Rise time max (usec)	Fall time max (usec)	C_{max} external to PSU	Peak noise (mVpk-pk)
PS_ON#	In	No	Yes	49.9K +/- 5%	0.8	2.06	N/A	50	50	No	N/A

PSU_ALERT# - (pin 11)

The signal will be high until status change of the PSU. By default, PSU_ALERT will be asserted between 5ms and 10ms of an overcurrent event.

Signal name	Input/ output to PSU	Open collector	3V3 logic	Signal pull up resistor value (Ohm)	Logic low max (V)	Logic high min (V)	Sink current max (mA)	Rise time max (usec)	Fall time max (usec)	C_{max} external to PSU (pF)	Peak noise (mVpk-pk)
Alert	Out	Yes	Yes	100K +/-20%	0.8	2.0	Note 1	50	250	N/A	250

Note 1 - Pull up to 3.3V through 100K ohms

I2C_SCL, I2C_SDA - (pins 7, 8)

No address pin is needed. It is recommended to pull up to 3.3V through 6.8K ohm resistor.

Signal name	Input/ output to PSU	Open collector	3V3 logic	Signal pull up resistor value in Server	Logic low max (V)	Logic high min (V)	Sink/ Source current max (mA)	Rise time max (usec)	Fall time max (nsec)	C_{max} external to PSU (pF)	Peak noise (mVpk-pk)	Pull up to 3.3V in Power Supply (kOhms)
SDA	I/O	No	Yes	1.2K +/-20%	0.8	2.0	6	1	250	120	250	6.8
SCL	I/O	No	Yes	1.2K +/-20%	0.8	2.0	6	1	250	120	250	6.8

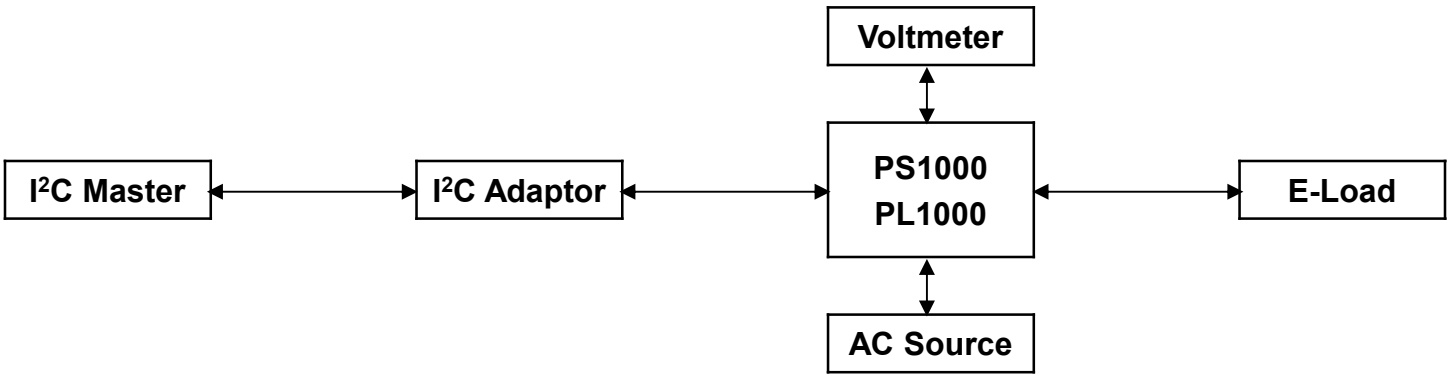
PMBus™ Interface Support

The PL1000 PS1000 is compliant with the industry standard PMBus™ protocol for monitoring and control of the power supply via the I²C interface port.

PL1000 PS1000 Series PMBus™ General Instructions

Equipment Setup

The following is typical I²C communication setup:



The I2C address of the PSU will be 0xB0 (which is also the default address) when address is LOW and will be 0xB2 when Address is pulled High.

400Khz I2C interface speed

PL1000 PS1000 Series Support PMBus™ Command List

The PL1000 PS1000 is compliant with the industry standard PMBus™ protocol for monitoring and control of the power supply via the i²C interface port.

PL1000 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
01h	OPERATION	80	R/W	1		Used to turn the unit ON/OFF.
	b7:6	10b				00 – Immediate Turn OFF 10 – PSU ON
	b5:4	00b				
	b3:2	00b				
	b1:0	00b				Reserved
03h	CLEAR_FAULTS	0	S			
04h	PHASE(overloaded)		R	1		
3Bh	FAN_COMMAND_1	-	R/W	2	Linear	Adjusts the operation of the Fans. To set the fans to 100% duty cycle, set the data bytes to 0x64 0x00 (Data Byte Low, Data Byte High). To set the fans to 30% duty cycle, set the data bytes to 0x1E 0x00 (Data Byte Low, Data Byte High).
3Ch	FAN_COMMAND_2	-	R/W	2	Linear	Adjusts the operation of the Fans. To set the fans to 100% duty cycle, set the data bytes to 0x64 0x00 (Data Byte Low, Data Byte High). To set the fans to 30% duty cycle, set the data bytes to 0x1E 0x00 (Data Byte Low, Data Byte High).
19h	CAPABILITY (Overloaded)		R	1		
	b7	1b				Packet Error Checking is supported
	B6:5	01b				Maximum supported bus speed is 400 Khz
	b4	1b				ALERT# signal with expected response supported
	b3	1b				if Battery present (supported), 0 if Battery NOT present (not supported)
	b2	1b				Supports all updates based on spec version V 0.94 and above
	b1	1b				Supports Blackbox Registers
	b0	0b				Reserved
1Ah	Query		BR/BW	1		The QUERY command is used to ask a PMBus device if it supports a given command
1Bh	SMBALERT_MASK (Overloaded)		BR/BW	2		This command provides the ability to configure events that may trigger SMBALERT signal.
46h	IOUT_OC_FAULT_LIMIT		R	2	Linear	Sets the Over current threshold in Amps.
4Ah	IOUT_OC_WARN_LIMIT		R	2	Linear	Sets the Over Current Warning threshold in Amps.
55h	VIN_OV_FAULT_LIMIT		R	2	Linear	Sets input over-voltage threshold.
57h	VIN_OV_WARN_LIMIT		R/W	2	Linear	Sets the threshold of input voltage that triggers high voltage warning.
5Bh	IIN_OC_FAULT_LIMIT		R	2	Linear	Sets the threshold for input current that causes over-current fault.
5Dh	IIN_OC_WARN_LIMIT		R/W	2	Linear	
6Bh	PIN_OP_WARN_LIMIT		R/W	2	Linear	

PL1000 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
79h	STATUS_WORD		R	2		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 has occurred.
	b12 – MFR					A manufacturer specific fault or warning has occurred. BBU Fault or wanring has occurred refer to 80h (BATT_ATTN_INDICATOR)
	b11 – POWER_GOOD#					The POWER_GOOD signal is de-asserted
	b10 - FANS					A fan or airflow fault or warning has occurred.
	b9 – OTHER					A bit in STATUS_OTHER is set.
	b8 – UKNOWN					A fault type not given in bits [15:1] of the STATUS_WORD has been detected.
	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	-	R	1		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 that the highest permissible voltage.
	b2					TON_MAX_FAULT
	b1					TOFF_MAX Warning
	b0					Reserved

PL1000 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
7Bh	STATUS_IOUT		R	1		Output Current related faults and warnings
	b7					IOUT Over current Fault
	b6					IOUT Over current And Low Voltage shutdown Fault
	b5					IOUT Overcurrent Warning
	b4					IOUT Undercurrent Fault
	b3					Current Share Fault Set if Ishare level is much greater or lower than the actual output current. Refer to Output Specifications (Table 3) for Current sharing limits.
	b2					Power Limiting
	b1					POUT Overpower Fault
	b0					POUT Overpower Warning
7Ch	STATUS_INPUT		R	1		Input related faults and warnings
	b7					VIN Overvoltage Fault
	b6					VIN Overvoltge Warning
	b5					VIN Undervoltage Warning
	b4					VIN Undervoltage Fault
	b3					Unit is OFF for insufficient Input Voltage
	b2					IIN Overcurrent Fault
	b1					IIN Overcurrent Warning
	b0					PIN overpower Warning
7Dh	STATUS_TEMPERATURE	-	R	1		Temperature related faults and warnings
	b7					Overtemperature Fault
	b6					Overtemperature Warning
	b5					Undertemperature Warning
	b4					Undertemperature Fault
	b3:0					reserved
7Eh	STATUS_CML	-	R	1		Communications, Logic and Memory
	b7					Invalid or unsupported Command Received
	b6					
	b5					Packet Error Check Failed
	b4					Memory Fault Detect, CRC Error
	b3					
	b2					
	b1					
	b0					

PL1000 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
80h	STATUS_MFR_SPECIFIC (BATT_ATTN_INDICATOR)	-	R/W	1	-	
	b7 - OT	-				1 - Battery over-temperature is detected *In charging Cell temperature > 53 degree C or Cell temperature < 3 degree C *Not charging Cell temperature > 50 degree C or Cell temperature < 5 degree C Or discharge and charge converter OT is detected 0 - Battery over-temperature is not detected
	b6 –SOC_LT					1 - State of Charge threshold breach Flag. Active when set. Indicates battery state of charge is below SOC_LT threshold (say <25%) 0 - State of charge is higher than critical (SOC_LT) threshold
	b5 - UVP					1- Status bit that indicates one or more cells is below the cell minimum operating voltage threshold. Or the discharge and charge converter output is < out of limit UVP 0 - Under voltage is not detected
	b4 – OV_CHG					1 - Status bit that indicates one or more cells is above the cell voltage threshold that indicates an overcharge condition. Charging is prohibited. Active when set. 0 - No over voltage charge is detected
	b3 – OC_CHG					1 - Indicates Overcurrent in charge condition detected. Active when set. Charge is prohibited until flag is cleared. 0 - Battery charge current is normal
	b2 – OC_DSCHG					1 - Indicates Overcurrent in discharge condition detected. Active when set. Discharge is prohibited until flag is cleared. Or the discharge and charge converter output is > out of limit OCP 0 - Battery discharge current is normal
	b1 - CF					1 - Status bit that indicates Cell imbalance or Weak Cell detected. Active when set. 0 - No cell imbalance or weak cell detected.
88h	READ_VIN	-	R	2	Linear	Returns input Voltage in Volts ac.
89h	READ_IIN	-	R	2	Linear	Returns input Current in Amperes
8Ch	READ_IOUT	-	R	2	Linear	Returns the output current in amperes.
8Dh	READ_TEMPERATURE_1	-	R	2	Linear	PSU infernal hotspot (inside PSU)
8Eh	READ_TEMPERATURE_2	-	R	2	Linear	PSU Air inlet temp (inside PSU)
8Fh	READ_TEMPERATURE_3	-	R	2	Linear	PSU Air Outlet temp (inside PSU)
96h	READ_POUT	-	R	2	Linear	Returns the output power, in Watts.
97h	READ_PIN	-	R	2	Linear	Returns the input power, in Watts.
99h	MFR_ID		BR,	15	ASCII	Abbrev or symbol of manufacturers name.
9Ah	MFR_MODEL		BR/BW	15	ASCII	Manufacturers Model number, ASCII format
9Eh	MFR_SERIAL		BR/BW	15	ASCII	Unit serial number, ASCII format.
ADh	IC_DEVICE_ID	-	BR	20	ASCII	

PL1000 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
D0h	BATT_ARM	-	R/W	1		This command is a Read/Write Byte command which can enables/disables PSU to enter battery backup mode when AC is loss. Default setting is battery backup mode enabled. This command's data content will be reset to default value after PSU shutdown.
D1h	PSU_FEED	-	R/W	1		This command is a Read Byte command which returns the active feed of the PSU. This register will follow the ITIC requirements as detailed in table below.
D2h	BATT_OP_TIME_100_LOAD	-	NA/R	2	Linear	This command returns the number of seconds the battery can deliver power at 100% (full load) of its power output capacity, starting from 100% or full capacity. This command follows the same request/response format as the standard PMBUS command, READ_POUT (0x96) specified in the PMBUS SPEC.
D5h	BATT_POUT	-	NA/R	2	Linear	This command returns the battery power output in Watts. This command follows the same request/response format as the standard PMBUS command, READ_POUT (0x96) specified in the PMBUS SPEC.
D6h	BATT _STATUS	-	NA/R	2		
	b15:8 – Reserve					Reserve
	b7 – BAL_ACTIVE					1 - Status bit indicating that cells are being balanced. Active when set.
	b6 – EP_PRESENT					1 - Status bit that indicates battery management system is running on external power (+12Vsb). This represents normal operating condition. Active when set.
	b5 – PCHG_EN					1 - Status bit that indicates that battery cell voltage conditions are below normal charging limits, but above Permanent Fail limits. Active when set.
	b4 – DSCHG_EN					1- Status bit that indicates battery conditions are normal, and things like SOC, cell voltage, balance, etc. are suitable for discharge. Active when set.
	b3 – CHG_EN					1- Status bit that indicates battery conditions are normal, and battery is capable of accepting charge. Active when set.
	b2 – Charging					1- Status bit indicating that charge current is detected. Active when set. 0- Not discharging
	b1 – Discharging					1- Status bit indicating that discharge current is detected. Active when set. 0- Not discharging
	b0 – Initialized					1 - Assembled in battery manufacturer 0 - EEPROM Error is detected

PL1000 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
D7h	BATT_STAT_OF_CHARGE		NA/R	2	Linear	This command returns the battery charge level and is presented as a percentage between 0 to 100%. This command follows the same request/response format as the standard PMBUS command, READ_POUT (0x96) specified in the PMBUS SPEC.
D8h	BATT_HEALTH_TEST		R/W	2		This command is a Write Word command which can force battery to enter backup mode for 2 seconds. After test, user can read BATT_HEALTH_STATUS (0xD6) and BATT_FAULT_INDICATOR (0x80) to check if Battery can function properly.
D9h	BATTPACK_STAT_OF_HEALTH		R/W	2	Linear	This command returns the State of Health of the battery and is presented as a percentage between 0 to 100%. This command follows the same request/response format as the standard PMBUS command, READ_POUT (0x96) specified in the PMBUS SPEC.
DAh	MAX_POUT	-	R/W	2	Linear	The PSU will record the maximum observed output power (monitoring granularity: 1 second) and report this value via this command in a 2byte linear format. Refer to the standard PMBUS command IIN_OC_FAULT_LIMIT which has a similar format. The monitoring window can be reset by the host by writing the value=0 using this command (write of any other value should return error). Note that upon reset of the monitoring window, the PSU should overwrite the maximum power with the instantaneous power reading. Also, the maximum power reading should be persistent across PSU MCU resets (following a firmware update).
DBh	BATT_SOC_LOWER_LIMIT	-	R/W	1	Linear	This command sets the lower limit for the battery state of charge in percentage (between 0 and 100%) The set limit value will be used for triggering the ALERT# signal on the power device.
DCh	BATT_OC_CHARGE_LIMIT	-	R/W	2	Linear	This command sets the over current limit in Amperes associated with battery charge current. This command follows the same request/response format as the standard PMBUS command, IOUT_OC_FAULT_LIMIT. The set limit value will be used for triggering the ALERT# signal on the power device.
DDh	BATTPACK_VOLTAGE	-	R/W	2	Linear	This command returns the battery pack voltage in volts. This command follows the same request/response format as the standard PMBUS command, READ_VOUT (0x8B) specified in the PMBUS SPEC.
DEh	BATTPACK_CURRENT	-	R/W	2	Linear	This command returns the battery pack current in Amps. This command follows the same request/response format as the standard PMBUS command, READ_IOUT (0x8C) specified in the PMBUS SPEC.

PS1000 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
01h	OPERATION	80	R/W	1		Used to turn the unit ON/OFF.
	b7:6	10b				00 – Immediate Turn OFF 10 – PSU ON
	b5:4	00b				
	b3:2	00b				
	b1:0	00b				Reserved
03h	CLEAR_FAULTS	0	S			
04h	PHASE(overloaded)		R	1		
3Bh	FAN_COMMAND_1	-	R/W	2	Linear	Adjusts the operation of the Fans. To set the fans to 100% duty cycle, set the data bytes to 0x64 0x00 (Data Byte Low, Data Byte High). To set the fans to 30% duty cycle, set the data bytes to 0x1E 0x00 (Data Byte Low, Data Byte High).
3Ch	FAN_COMMAND_2	-	R/W	2	Linear	Adjusts the operation of the Fans. To set the fans to 100% duty cycle, set the data bytes to 0x64 0x00 (Data Byte Low, Data Byte High). To set the fans to 30% duty cycle, set the data bytes to 0x1E 0x00 (Data Byte Low, Data Byte High).
19h	CAPABILITY (Overloaded)		R	1		
	b7	1b				Packet Error Checking is supported
	B6:5	01b				Maximum supported bus speed is 400 Khz
	b4	1b				ALERT# signal with expected response supported
	b3	1b				if Battery present (supported), 0 if Battery NOT present (not supported)
	b2	1b				Supports all updates based on spec version V 0.94 and above
	b1	1b				Supports Blackbox Registers
	b0	0b				Reserved
1Ah	Query		BR/BW	1		The QUERY command is used to ask a PMBus device if it supports a given command,
1Bh	SMBALERT_MASK (Overloaded)		BR/BW	2		This command provides the ability to configure events that may trigger SMBALERT signal.
46h	IOUT_OC_FAULT_LIMIT		R	2	Linear	Sets the Over current threshold in Amps.
4Ah	IOUT_OC_WARN_LIMIT		R	2	Linear	Sets the Over Current Warning threshold in Amps.
55h	VIN_OV_FAULT_LIMIT		R	2	Linear	Sets input over-voltage threshold.
57h	VIN_OV_WARN_LIMIT		R/W	2	Linear	Sets the threshold of input voltage that triggers high voltage warning.
5Bh	IIN_OC_FAULT_LIMIT		R	2	Linear	Sets the threshold for input current that causes over-current fault.
5Dh	IIN_OC_WARN_LIMIT		R/W	2	Linear	
6Bh	PIN_OP_WARN_LIMIT		R/W	2	Linear	

PS1000 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
79h	STATUS_WORD		R	2		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 has 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					A bit in STATUS_OTHER is set.
	b8 – UKNOWN					A fault type not given in bits [15:1] of the STATUS_WORD has been detected.
	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	-	R	1		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 that the highest permissible voltage.
	b2					TON_MAX_FAULT
	b1					TOFF_MAX Warning
	b0					Reserved

PS1000 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
7Bh	STATUS_IOUT		R	1		Output Current related faults and warnings
	b7					IOUT Over current Fault
	b6					IOUT Over current And Low Voltage shutdown Fault
	b5					IOUT Overcurrent Warning
	b4					IOUT Undercurrent Fault
	b3					Current Share Fault Set if Ishare level is much greater or lower than the actual output current. Refer to Output Specifications (Table 3) for Current sharing limits.
	b2					Power Limiting
	b1					POUT Overpower Fault
	b0					POUT Overpower Warning
7Ch	STATUS_INPUT		R	1		Input related faults and warnings
	b7					VIN Overvoltage Fault
	b6					VIN Overvoltge Warning
	b5					VIN Undervoltage Warning
	b4					VIN Undervoltage Fault
	b3					Unit is OFF for insufficient Input Voltage
	b2					IIN Overcurrent Fault
	b1					IIN Overcurrent Warning
	b0					PIN overpower Warning
7Dh	STATUS_TEMPERATURE	-	R	1		Temperature related faults and warnings
	b7					Overtemperature Fault
	b6					Overtemperature Warning
	b5					Undertemperature Warning
	b4					Undertemperature Fault
	b3:0					reserved
7Eh	STATUS_CML	-	R	1		Communications, Logic and Memory
	b7					Invalid or unsupported Command Received
	b6					
	b5					Packet Error Check Failed
	b4					Memory Fault Detect, CRC Error
	b3					
	b2					
	b1					
	b0					

PS1000 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
88h	READ_VIN	-	R	2	Linear	Returns input Voltage in Volts ac.
89h	READ_IIN	-	R	2	Linear	Returns input Current in Amperes
8Ch	READ_IOUT	-	R	2	Linear	Returns the output current in amperes.
8Dh	READ_TEMPERATURE_1	-	R	2	Linear	PSU infernal hotspot (Inside PSU)
8Eh	READ_TEMPERATURE_2	-	R	2	Linear	PSU Air inlet temp (inside PSU)
8Fh	READ_TEMPERATURE_3	-	R	2	Linear	PSU Air Outlet temp (inside PSU) Only applies if a thermistor is present in the current hardware, else report 0x0000.
96h	READ_POUT	-	R	2	Linear	Returns the output power, in Watts.
97h	READ_PIN	-	R	2	Linear	Returns the input power, in Watts.
99h	MFR_ID		BR,	15	ASCII	Abbrev or symbol of manufacturers name.
9Ah	MFR_MODEL		BR/BW	15	ASCII	Manufacturers Model number, ASCII format
9Eh	MFR_SERIAL		BR/BW	15	ASCII	Unit serial number, ASCII format.
9Fh	FW Version Number		R	2	MSB/LSB	
A0h	FAULT_HISTORY		BR	24	-	
ADh	IC_DEVICE_ID	-	BR	20	Linear	
EFh	READ_FW_INFO	-	BR/BW	9	ASCII	
F0h	ENTER PROGRAMMING MODE		W	1		This command is used to enter into the firmware upgrade mode from application mode. The programming mode indicates which region should be erased. The power device will return failure when the host attempts to program (ENTER_PROGRAMMING) the active application region.
F1h	EXIT_PROGRAMMING_MODE		W	1		This command is used to jump to one of the three regions (typically following ENTER PROGRAMMING and WRITE PROGRAM MEMORY command sequence) which may involve reset to the power device. Upon executing this command, the power device will attempt to jump to the specified region (load the new firmware image). The power device will correspondingly update the “Active image” as part of the ‘READ_FW_INFO (0xEF) command if the load was successful. A jump to the bootloader region will result in (re) loading the active application image. Any failure while loading the new application image will result in the power device automatically reverting to the original application image (the active image before the firmware update).
F2h	FW_DELAYS		BR/BW	4		This command obtains the delay or wait time required between subsequent firmware update commands. This command takes 1 byte delay category argument (see below) and return 3 bytes of delay value.

PL1000 PS1000 Series Firmware Update Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
F8h	Send ROM Page		R/W	1		This command is used to change Flash memory page setting when host is reading/writing program memory. When used in READ mode, the command should return the current page in the flash memory.
FBh	WR_PROGRAM_MEM		BR			This command is used to transfer data from HEX file to the power device, and write into the program memory. Please refer to Table 21 – HEX File Data Format for more detailed information.
FCh	FW_UPDATE_STATUS					This command is used to get the firmware update status. This command will be called by the user to determine the status of the previously executed firmware update command using the 'status byte' (see status table below for all possible values) and WRITE or CLEAR STATUS: The status code can be cleared by writing a value of '0' to this command. A write value other than '0' should return failure. After clearing status, subsequent firmware status updates should be reflected in the read response.
FDh	RD_PROGRAM_MEM					It is used set target program memory address (middle byte and low byte) for reading. High byte is set using Send ROM Page (0xF8) command.

Firmware Update Command Description

Enter Programming Mode (0xF0)

This command is used to enter into the firmware upgrade mode from application mode. The programming mode indicates which region should be erased. The power device will return failure when the host attempts to program (ENTER_PROGRAMMING) the active application region.

1	7	1	1	8	1	8	1	8	1	1
S	Slave Address	W	A	Enter Programming Mode Command Code (0xF0)	A	Mode	A	PEC (Optional)	A	P

Name	Length	Description	Remark
Mode	1 byte	Programming Mode	0 – Bootloader 1 – Application Image A 2 – Application Image B 5 – No erase. Used by host to read program memory
PEC	1 byte	Packet Error Check	CRC8 code is calculated per SMBus Specification.

Send ROM Page (0xF8)

This command is used to change Flash memory page setting when host is reading/writing program memory. When used in READ mode, the command should return the current page in the flash memory.

Host need to extract 1 byte highlighted in green from HEX file and send as below format,

:020000040001F9

1	7	1	1	8	1	1	7	1	8	1	1
S	Slave Address	W	A	Send ROM Page (0xF8)	A	Sr	Rom Page (0x01)	A	Checksum	A	P

Name	Length	Description	Remark
Rom Page	1 byte	Flash memory page setting	Set target flash memory page in program memory.
Checksum	1 byte	Checksum	Arithmetic sum of all bytes sent, including slave address and its R/W bit. Note that this field is mandatory.

Write Program Memory (Write ROM data) (0xFB)

This command is used to enter into the firmware upgrade mode from application mode. The programming mode indicates which region should be erased. The power device will return failure when the host attempts to program (ENTER_PROGRAMMING) the active application region.

Name	Length	Description	Remark
Data Length	1 byte	Number of bytes in the data field.	16 (0x10) bytes of data are the usual values. Directly get from HEX file
Address offset	2 bytes	16-bit program memory address	Directly get from HEX file
Record Type	1 byte	Defining the type of the data field	Only below record types are supported: 00: Data Record 01: End of File Record 04: Extended Linear Address Record
Data Row	16 bytes	Each data row consists 16 bytes.	
Hex Checksum	1 byte	Checksum of HEX file	This checksum is calculated using all above bytes.

Host will skip the data length byte, HEX Checksum and record type byte, and then follow below format to write flash.

1	7	1	1	8		1	8	1	8	1	8	1		8	1	8	1	1
S	Slave Address	W	A	Write program memory Command Code (0xFB)		A	Address mid byte (from HEX file)	A	Address low byte (from HEX file)	A	Data Byte 1 (from HEX file)	A	…	Data byte 8 (from HEX file)	A	Check Sum (Optional)	A	P

1	7	1	1	8	1	8	1	8	1	8	1		8	1	8	1	1
S	Slave Address	W	A	Write program memory Command Code (0xFB)	A	Address mid byte (from HEX file)	A	Address low byte| 0x08 (from HEX file)	A	Data Byte 9 (from HEX file)	A	…	Data byte 16 (from HEX file)	A	Check Sum (Optional)	A	P

Below Table provides the program Memory (write Rom data) Command.

Name	Length	Description	Remark
Address Offset	2 bytes	16-bit program memory address	Directly get from HEX file, should add 0x08 to address low byte if send byte 9~16
Data	8 bytes	8 bytes of the data	

Read Program Memory (Send Target Address) (0xFD)

It is used set target program memory address (middle byte and low byte) for reading. High byte is set using Send ROM Page (0xF8) command.

To write target program memory address for reading, refer to table: Table 25 – write target program memory address for reading

1	7	1	1	8	1	8	1	8	1	8	1
S	Slave Address	W	A	Read Program Memory Command Code (0xFD)	A	Byte count (2)	A	Address Mid Byte	A	Address Low Byte	A

The power device will in turn return the data bytes in the following format. Host need to verify these data bytes with those in HEX file

1	7	1	1	8	1	8	1		1	8	1	8	1	1
Sr	Slave Address	R	A	Byte count (8)	A	Data Byte 1	A	…	A	Data byte 8	A	Check Sum (Optional)	N	P

Note that bytes 9 to 16 will be queried in a similar fashion with incremented address

Firmware Update Status (0xFC)

READ STATUS: This command is used to get the firmware update status. This command will be called by the user to determine the status of the previously executed firmware update command using the 'status byte' (see status table below for all possible values) and

WRITE or CLEAR STATUS: The status code can be cleared by writing a value of '0' to this command. A write value other than '0' should return failure. After clearing status, subsequent firmware status updates should be reflected in the read response.

1	7	1	1	8	1	1	7	1	1	8	1	8	1	1
S	Slave Address	W	A	FW update status command code (0xFC)	A	Sr	Slave Address	R	A	Status Byte	A	Checksum	N	P

Name	Length	Description	Remark
Status	1 byte	Firmware update status	Please refer to FIRMWARE UPGRADE STATUS CODE DEFINITION table (below) for status code definition
Checksum (Optional)	1 byte	Checksum	Arithmetic sum of all bytes received and sent, including slave address and its R/W bit. Note that the host program should check this checksum field to ensure the data integrity.

Status Code	Name	Description
0x00	No Error	No error on last received
0x01	Checksum error	Received checksum has error
0x02	Block number error	Block number in packet has error
0x03	Length error	Packet length error
0x04	I2C write error	Tried to write a read-only command
0x05	I2C read error	Tried to read a write-only command
0x06	Command error	Received a unsupported command
0x0B	Model ID Error	Received invalid firmware image
0x0C	Flash erase error	Program memory cannot be erased all to 0xFF status
0x0D	Flash erase OK	Program memory has been erased and verified
0x54	Error active region update attempt	Error attempting to update active application region
0x55	Erase In progress	Status when PSU is still erasing its external flash memory
0x56	Flash Write in Progress	Error when host sending 0xFB command too fast
0x57	Write Address Out of Bound	Error attempting to write program memory exceed expected range
0x58	Write Address not in sequence	Write address received by PSU is not in sequence

Note: OEM specific errors can be encoded using status codes from 0xF0 to 0xFF. Details pertaining to these codes will be obtained from OEM data sheet.

Exit Programming Mode (0xF1)

This command is used to jump to one of the three regions (typically following ENTER PROGRAMMING and WRITE PROGRAM MEMORY command sequence) which may involve reset to the power device.

Upon executing this command, the power device will attempt to jump to the specified region (load the new firmware image). The power device will correspondingly update the “Active image” as part of the ‘READ_FW_INFO (0xEF) command if the load was successful.

A jump to the bootloader region will result in (re) loading the active application image.

Any failure while loading the new application image will result in the power device automatically reverting to the original application image (the active image before the firmware update).

Note that EXIT_PROGRAMMING_MODE command may also be executed in isolation (without corresponding ENTER PROGRAMMING and WRITE PROGRAM MEMORY command sequence) to jump to different region of firmware.

1	7	1	1	8	1	8	1	8	1	1
S	Slave Address	W	A	Exit Program Memory Command Code (0xF1)	A	Mode	A	Checksum	A	P

Name	Length	Description	Remark
Mode	1 byte	Exit Mode	0 – Jump to Bootloader 1 – Jump to Application Image A 2 – Jump to Application Image B 3 – Exit Programming Mode Only. Do not reset firmware
Checksum	1 byte	Checksum	Arithmetic sum of all bytes sent, including slave address and its R/W bit. Note that this field is mandatory.

READ_FW_INFO (0xEF)

This command will be used by the host to query details regarding the firmware image and the host will provide the queried image name (Image A (0xA) or Image B (0xB) or BootLoader (0x0)) as input to this command.

1	7	1	1	8	1	8	1	8	1
S	Slave Address	W	A	Read Firmware Revision Command Code (0xEF)	A	Byte count (1)	A	Image Queried (0xA or 0xB or 0x0)	A

The power device upon receiving the above packet will respond with the following details

1 Active Byte (0x1 indicate active image, 0x0 indicates inactive image)

When bootloader image is active, it indicates that the application image is being loaded (and neither A nor B will be active at this time)

8 Revision Bytes represent the firmware revision number string in ASCII format

Note: OEM specific errors can be encoded using status codes from 0xF0 to 0xFF. Details pertaining to these codes will be obtained from OEM data sheet.

1	7	1	1	8	1	8	1	8	1	8	1	8	1	1
Sr	Slave Address	R	A	Byte count (9)	A	Active Byte (0x0 or 0x1)	A	…	A	Revision bytes	A	Check Sum (Optional)	N	P

FW_ DELAYS (0xF2)

This command obtains the delay or wait time required between subsequent firmware update commands. This command takes 1 byte delay category argument (see below) and return 3 bytes of delay value.

Input (Delay categories):

- BaseDelay (0x0)
- Enter Programming or Erase (0x1)
- DataRead (0x2)
- DataWrite (0x3)
- SetPage (0x4)
- Exit Programming or Reset (0x5)

1	7	1	1	8	1	8	1	8	1
S	Slave Address	W	A	Get firmware delays Command Code (0xF2)	A	Byte count (1)	A	Category Queried (0x0, …, 0x5)	A

For the input argument, BaseDelay (0x0), the power device will return the scaling factor in microseconds which will be used for the rest of the categories. This has to be 100 microseconds as default. For other inputs, the delay will be present with respect to this scaling factor. For instance, a value of 1000 for Erase (0x1) will indicate a delay of 100 milliseconds.

1	7	1	1	8	1	8	1	8	1	8	1	1
Sr	Slave Address	R	A	Byte count (3)	A	Delay High Byte	A	Delay Mid Byte	A	Delay Low Byte	A	P

Expected Command Accuracy and Update Frequency

Command	Measurement Accuracy	Update Frequency
READ_IOUT	+/- 2.5%	100ms
READ_POUT	+/- 2.5%	100ms
READ_PIN	+/- 2.5%	100ms
BATT_POUT	+/- 2.5%	100ms
BATT_STAT_OF_CHARGE	+/- 2.5%	100ms

Battery Output Behaver

Expect the PSU to deliver the required voltage (12V or 48V) as long as there is AC input or when the batteries have energy to support the voltage output. We do not expect the PSU to turn OFF battery output or alter output voltage autonomously. The PSU will receive an explicit PMBUS command (refer to BATT_ARM and OPERATION PMBUS command) to shut off power output.

PSU Fault Status and SMB_Alert Behavior

Fault status reported by the PSU (via commands such as STATUS_WORD, STATUS_VOUT, STATUS_IOUT, STATUS_INPUT, STATUS_TEMPERATURE) should be sticky or remain un-cleared until an explicit CLEAR_FAULTS command is received.

Note that a PSU AC power cycle or PS_ON toggle should NOT clear the fault event.

Note that the SMB_ALERT signal should be sticky as long as PSU fault status is in un-cleared state

SMB_ALERT should be triggered within 1-5ms of over current detection and within 10ms of other alert events such as under voltage, AC loss etc. (When enabled for these events).

SMB_ALERT should not be triggered for any reason other than over current. All other alert triggers should be disabled by default. Note: No condition other than over current should cause SMB_ALERT to assert.

The SMB_ALERT should be non-sticky, unlike the log bits the SMB_ALERT should only assert when the alerting condition (over current) is currently active. When SMB_ALERT is asserted it should assert for a minimum duration of 20ms, and deassert when the condition subsides thereafter.

SMB_ALERT should be triggered within +/- 1% deviation from the ALERT threshold. Note that this deviation accuracy refers to the difference between the measured alert event reading and set alert event threshold (and NOT the deviation from actual event reading).

The IOUT_OC_FAULT_LIMIT and IOUT_OC_WARN_LIMIT register should be factory initialized to the values specified in the SMB_ALERT section.

Battery Sourcing

When AC power is lost the PSU will source from battery. The battery should run until fully discharged, or the PSU receives the BATT_ARM with 0xCC. See PMBus Section (D0 command). Upon receipt of this command the PSU must attempt to source from AC, losing power if no AC is present.

No artificial timelines or shutdown conditions must be placed upon the battery. The battery is expected to source until depletion.

Upon AC loss the PSU will source from battery, a server motherboard based microprocessor that is external too and fully independent of the PSU will ready the server for shutdown by flushing necessary caches. Once complete the server side microprocessor will send BATT_ARM 0xCC to the PSU followed by BATT_ARM 0xAA.

The system cache flush may take up to 500 seconds, however the server power is typically below 200W during this time.

Miscellaneous

All SET PMBUS commands must be persistent across PSU resets (Note that Unless otherwise specified all STATIC battery/PSU parameters populated in the firmware as part of the supported PMBUS commands should indicate the value at the end of 4 years of operation at 30C. For instance, BATT_OP_TIME_100_LOAD is one example of a PMBUS command with static value. The peak shaving (using battery energy) operation must be disabled when battery_health_test command is in progress.

Application Notes

Input Power Sharing

The three input modules will share the load so that input current sharing between modules meets the requirements in the table below:

Total Input Power	Input current share accuracy
0 -100W	within 100mA
100W-325W	+/- 10%
325W-350W	+/- 7.5%
350W-400W	+/-5%
400W-1100W	+/- 3%

Battery/ AC input Power sharing

The battery output will be adjustable to allow power sharing with the AC input. Normally battery boost voltage will be set to 12V. Battery boost voltage can be increased to take a share of the 12.25 output load.

Input Voltage Selector (IVS) Operation

The PSU will normally run off of Default Feed. When Default Feed drops for more than 8ms, the IVS will switch to Backup Feed within 12ms. The LEDs will be driven green/yellow/green continuously while operating on Backup Feed as described in LED section. When AC voltage on Default Feed is back in regulation, there will be a 10-20 second delay and then power will be switched back to Default Feed. Note that if any single phase on Default Feed drops out of regulation, all three phases must be switched to Backup Feed. In other words, all three IVS's will be synchronized so that all three switch together. Note that if while on Backup Feed, Default Feed comes back and Backup Feed experiences an interruption, the 10-20 second switchback delay is not required.

The power supply will power up and operate normally when only one feed is initially applied. Whether Default Feed or Backup Feed.

Relay contact switching failure: If a feed is lost and the IVS switches to the other feed, if one of the 3 modules does not stay powered up, it will be assumed one of the relays operating on that module has a welded contact. Under this situation, the relays for the unpowered module will be switched back to the unpowered feed. Upon PSON toggle or AC removal, the IVS can retry to operate all modules off the operating feed. If the module fails to operate, the relays for that module will again be switched to the non-activated feed.

When running on a single feed, and a loss of one or two input phases occurs, each module that has input voltage within the regulation limits will continue to run as long as the maximum load per module is not exceeded.

Battery Backup Operation

This section describes the battery backup operation.

Following are the battery backup requirements. Note that minimum battery operation ambient air temperature will be 20C.

1.The battery will use 8 Panasonic UR18650RX cells or competitor's cells with similar or better performance. Key parameters are Capacity, impedance, self-discharge, aging.

2. Partial discharge duty cycle will be 2 discharges per year at a 5 second discharge and 150W max.

3. Full discharge duty cycle will be 1 discharge per 2 years for condition in table above.

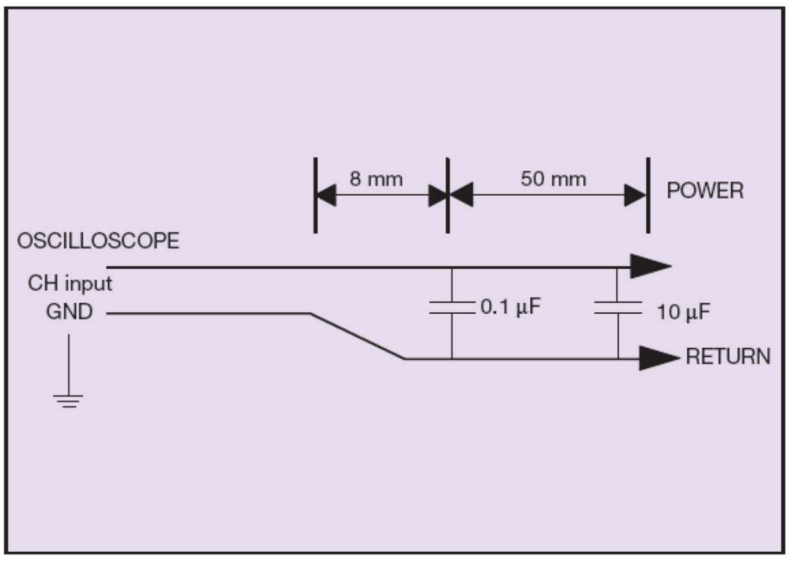
4. The power supply will be capable of, when given the command via PMBUS, to go to battery power for one to three seconds then return to AC power. This is to check for weak or bad cells within the battery pack. See firmware section 9 for specific command description and register location.

Battery Self Discharge

The battery will not self-discharge more than 34 kilo Joules per year at an average ambient temperature of 27degC.

Output Ripple and Noise Measurement

The setup outlined in the diagram below has been used for output voltage ripple and noise measurements on the PL1000 PS1000 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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