ARTESYN M-CRPS CSU2400AT-3-3M0

2400 W Distributed Power System

PRODUCT DESCRIPTION

Advanced Energy's Artesyn CSU2400AT-3-3M0 power supply is designed to provide a flexible power conversion solution for compute, storage, and networking equipment in the modular hardware common redundant power supply (M-CRPS). The 2400 W model is in the standard form factor of 1 U x 73.5 mm x 185 mm. The series of power supply can cover cost-sensitive entry level systems, or power hungry applications where there are space constraints.

SPECIAL FEATURES

- Ultra-high density
- 1U power supply
- Active power factor correction
- EN61000-3-2 harmonic compliance
- Inrush current control
- 80 PLUS® Titanium efficiency
- N+N, N+1 redundant
- Hot-pluggable
- Active current sharing
- Closed loop throttle
- Cold redundancy
- 2 year warranty
- PMBus™ compliant

SAFETY

- UL/cUL
- CB Test Certificate
- CE Mark
- KC
- EAC
- BIS
- CQC
- BSMI

COMPLIANCE

- Conducted/Radiated EMI Class A Limits
- RoHS
- IEC 60950/62368

AT A GLANCE

Total Power

90 to 132 VAC, 1400 W

180 to 264 VAC, 2400 W

192 to 310 VDC, 2400 W

Input Voltage

90 to 264 VAC

192 to 310 VDC

Number of Outputs

Main and Standby

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SECTION 1 MODEL NUMBERS

Standard	Output Voltage	Minimum Load	Maximum Load	Standby Supply	Air Flow Direction
CSU2400AT-3-3M0	12.2 VDC	0 A	196.7 A	12.0 VDC at 3.0 A	Forward (DC Connector to Handle)

Options

None

Family Comparison

Model Number	Input Type	Output Voltage	Output Power	Standby Output	Efficiency	Dimension
CST1800AT-3-3M0	AC/DC Input	12.2 VDC	1800 W	12 VDC at 3.5 A	Titanium	1U x 2.36” x 7.28”
CSU2400AT-3-3M0	AC/DC Input	12.2 VDC	2400 W	12 VDC at 3.0 A	Titanium	1U x 2.89” x 7.28”
CSU3200AT-3-3M0	AC/DC Input	12.2 VDC	3200 W	12 VDC at 3.0 A	Titanium	1U x 2.89” x 7.28”

SECTION 2 ELECTRICAL SPECIFICATIONS

2.1 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 DC continuous operation	CSU2400AT-3-3M0 CSU2400AT-3-3M0	$V_{IN,AC}$ $V_{IN,DC}$	90 192	- 240	264 310	VAC VDC
Maximum Output Power	CSU2400AT-3-3M0	$P_{O,max}$	-	-	2400[1]	W
Isolation Voltage Input to outputs	CSU2400AT-3-3M0		-	4242	-	VDC
Operating Temperature	CSU2400AT-3-3M0	T_A	-5	-	55	°C
Storage Temperature	CSU2400AT-3-3M0	T_{STG}	-40	-	70	°C
Humidity (non-condensing) Operating Non-operating	CSU2400AT-3-3M0 CSU2400AT-3-3M0		5 5	- -	95 95	% %
Altitude[2] Operating Non-operating	CSU2400AT-3-3M0 CSU2400AT-3-3M0		- -	- -	10,000[2] 50,000	feet feet
MTBF[3]	CSU2400AT-3-3M0		400	-	-	KHours
Operating Life[4]	CSU2400AT-3-3M0		5	-	-	Years
Fan L10 Life @ 50°C	CSU2400AT-3-3M0		-	-	43.2	KHours

Note 1 - Output power is 2400 W at 180 to 264 VAC.
Note 2 - Safety creepage/clearance rated for 5,000 m altitude for CQC.
Note 3 - MTBF prediction is completed in accordance with Telcordia SR-332, Method 1 Case 3, 40°C.
Note 4 - It is calculated under 55°C ambient temperature, 80% load, nominal input.

SECTION 2 ELECTRICAL SPECIFICATIONS

2.2 Input Specifications

Table 2. Input Specifications

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, AC	All	$V_{IN,AC}$	90	-	264	VAC
Operating Input Voltage, DC	All	$V_{IN,DC}$	192	240	310	VDC
Input AC Frequency	All	$f_{IN,AC}$	47	50/60	63	Hz
Maximum Input Current	$V_{IN,AC}$ = 90 VAC, 1400 W $V_{IN,AC}$ = 120 VAC, 1400 W $V_{IN,AC}$ = 180 VAC, 2400 W $V_{IN,AC}$ = 240 VAC, 2400 W $V_{IN,AC}$ = 264 VAC, 2400 W $V_{IN,DC}$ = 192 VDC, 2400 W $V_{IN,DC}$ = 240 VDC, 2400 W	$I_{IN,max}$	- - - - - - -	- - - - - - -	17.9 13.2 14.7 10.9 9.9 13.6 10.9	A A A A A A A
No Load Input Current (V_O = On, I_O = 0 A, I_{SB} = 0 A)	$V_{IN,AC}$ = 180 VAC	$I_{IN,no-load}$	-	-	200	mA
No Load Input Power (V_O = On, I_O = 0 A, I_{SB} = 0 A)	$V_{IN,AC}$ = 180 VAC	$P_{IN,no-load}$	-	-	10	W
Standby Input Current (V_O = Off, I_{SB} = 0 A)	$V_{IN,AC}$ = 180 VAC	$I_{IN,Standby}$	-	-	200	mA
Standby Input Power (V_O = Off, I_{SB} = 0 A)	$V_{IN,AC}$ = 180 VAC	$P_{IN,Standby}$	-	-	3.5	W
Input iTHD	$V_{IN,AC}$ = 240 VAC $I_O \geq 0\% I_{O,max}$ $I_O \geq 5\% I_{O,max}$ $I_O \geq 10\% I_{O,max}$ $I_O \geq 20\% I_{O,max}$ $I_O \geq 50\% I_{O,max}$ $I_O \geq 100\% I_{O,max}$	iTHD	- - - - - -	- - - - - -	25 25 10 7.5 5 4	%
Harmonic Line Currents	All	THD		Per EN61000-3-2		
Power Factor	$I_O = 10\% I_{O,max}$ $I_O = 20\% I_{O,max}$ $I_O = 50\% I_{O,max}$ $I_O = 100\% I_{O,max}$	PF	0.92 0.96 0.98 0.99	- - - -	- - - -	
Startup Surge Current (Inrush)[1]		$I_{IN,surge}$	-	-	35	Apk
Leakage Current to Earth Ground[2]			-	-	0.583	mA
Turn-on Voltage	AC Input	$V_{IN,AC}$	84	-	90	VAC
Recommended 5 V_{RMS} hysteresis	DC Input	$V_{IN,DC}$	180		192	VDC
Turn-off Voltage	AC Input	$V_{IN,AC}$	79	-	85	VAC
Recommended 5 V_{RMS} hysteresis	DC Input	$V_{IN,DC}$	175		187	VDC

Note 1 - AC line inrush current should not exceed 35 A peak ignoring the initial 500 us of the EMI filter charge, for up to one-half of the AC cycle, after which the power supply is allowed to have a secondary inrush event for up to PSU model label current rating Amperes and lasting for up to 2500 ms, the input current should be no more than the specified maximum input current. The peak inrush current should be less than the ratings of its critical components (including input fuse, bulk rectifiers, and surge limiting device).

Note 2 - Leakage current is based upon 6 power supplies in parallel, to meet 3.5 mA limit at platform level.

SECTION 2 ELECTRICAL SPECIFICATIONS

2.2 Input Specifications

Table 2. Input Specifications						
Parameter	Condition	Symbol	Min	Typ	Max	Unit
Operating Efficiency	$V_{IN,AC}$ = 90 VAC, 1400 W $V_{IN,AC}$ = 100 VAC, 1400 W $V_{IN,AC}$ = 120 VAC, 1400 W $V_{IN,AC}$ = 180 VAC, 2400 W $V_{IN,AC}$ = 200 VAC, 2400 W $V_{IN,AC}$ = 240 VAC, 2400 W $V_{IN,AC}$ = 264 VAC, 2400 W $V_{IN,DC}$ = 192 VDC, 2400 W $V_{IN,DC}$ = 240 VDC, 2400 W $V_{IN, DC}$ = 310 VDC, 2400 W	η	87.0 88.0 89.0 91.0 91.5 92.5 93.0 92.0 92.5 93.0	- - - - - - - - - -	- - - - - - - - - -	% % % % % % % % % %
Hold-up Time	45% load 100% load		20 11	- -	- -	ms ms

SECTION 2 ELECTRICAL SPECIFICATIONS

2.3 Output Specifications

Table 3. Output Specifications

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Factory Set Voltage	$V_{IN,AC}$ = 230 VAC I_O = 50%$I_{O,max}$ T_A = 25^{O}C	V_O	12.17	12.20	12.23	VDC
	$V_{IN,AC}$ = 230 VAC I_{SB} = 50%$I_{SB,max}$ T_A = 25^{O}C	V_{SB}	12.045	12.075	12.105	VDC
Dynamic Loading	100% load change[1], slew rate 2.5 A/us, test capacitive load[3] 3,300 uF	V_O	11.04	-	12.96	VDC
	70% load change, slew rate 2.5 A/us, test capacitive load[3] 4,400 uF	V_O	11.28	-	12.72	VDC
	60% load change[2], slew rate 2.5 A/us, test capacitive load[3] 1,000 uF	V_O	11.16	-	12.84	VDC
	60% load change[2], slew rate 2.5 A/us, test capacitive load[3] 2,200 uF	V_O	11.28	-	12.72	VDC
	60% load change[2], slew rate 2.5 A/us, test capacitive load[3] 6,600 uF	V_O	11.40	-	12.60	VDC
	1 A load change, slew rate 0.5 A/us, test capacitive load[3] 1000 uF	V_{SB}	11.04	-	12.96	VDC
Output Ripple, pk-pk	Measured at the output mating connector with a 10 uF/16 V Low ESR capacitor and a 0.1 uF ceramic capacitor and at 20 MHz bandwidth[4]	V_O	-	-	120	mV_{PK-PK}
		V_{SB}	-	-	120	mV_{PK-PK}
Output Current	90 VAC ≤ Vin ≤ 132 VAC 180 VAC ≤ Vin ≤ 264 VAC All	I_O I_O I_{SB}	0[5] 0[5] 0	- - -	114.75 196.72 3.0	A
Main Output Current Share Accuracy	30% to 100% $I_{O,max}$	$\%I_{O,max}$	-	-	+/-2	%
Number of Parallel Units	Main output current share connected		-	-	6	Units
Load Capacitance	Main Output	C_O	3300	-	70,000	uF
	Standby	C_O	270	-	4700	uF
	External Capacitance[6]	C_O	-	-	2,000	uF

Note 1 - For 100% step dynamic condition it is tested from 5% to 105% loading.
Note 2 - For step loading condition +12 V minimum loading is 5% of rated current and the step can be anywhere between 5% of rated current to max load. E.g., if the 100% load rated current of the power supply is 108 A, then the minimum loading will be 5.4 A.
Note 3 - The capacitor type used for this test is Aluminum Electrolytic.
Note 4 - An additional 2200 uF low ESR electrolytic capacitor is required to be placed in parallel to reduce switching ripple.
Note 5 - Minimum loading is 5% pf rated current for load response testing.
Note 6 - For cold redundancy.

SECTION 2 ELECTRICAL SPECIFICATIONS

2.4 System Timing Specifications

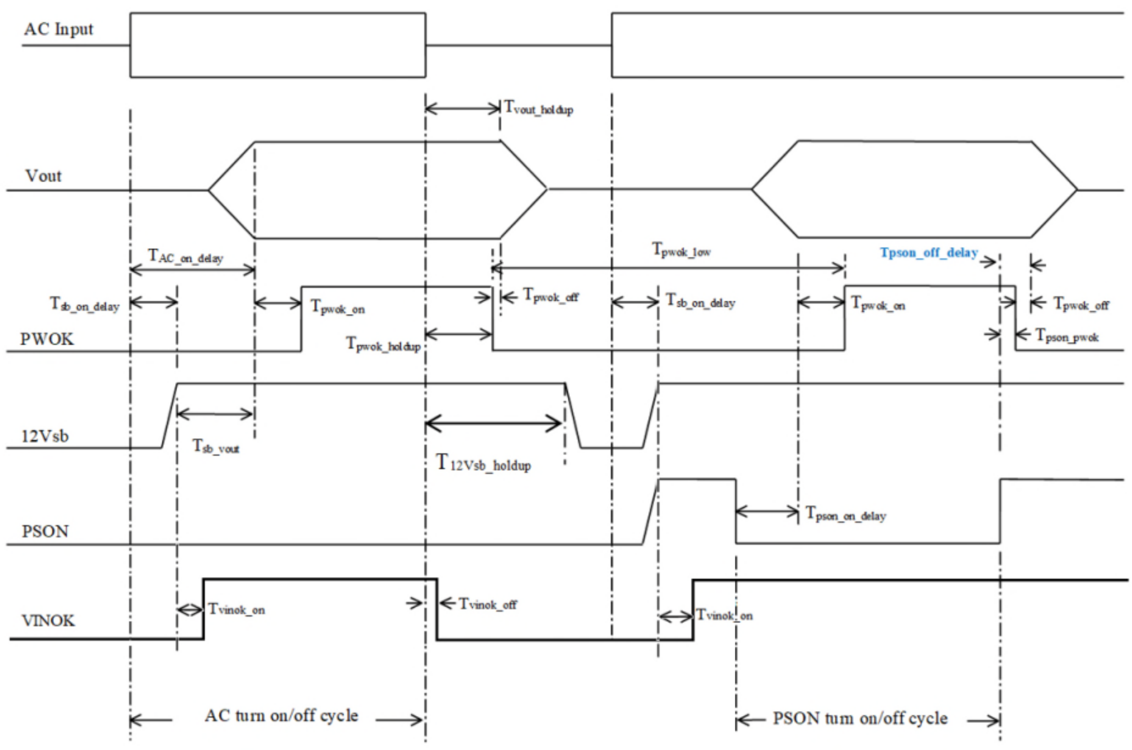
Table 4. System Timing Specifications

Label	Parameter	Min	Typ	Max	Unit
T_{vout_rise}	Output voltage rise time for 12V and $12V_{SB}$ from 10% to within regulation limits.	10	-	70	ms
T_{off_latch}[1]	This is the time the power supply unit must stay off when being powered off with loss of input. Both outputs must meet this off time: 1) whenever P_{WOK} is de-asserted for the 12V output; 2) whenever the $12V_{SB}$ output drops below regulation limits.	500	-	1000	ms
$T_{sb\_on\_delay}$	Delay from input being applied to $12V_{SB}$ being within regulation.	-	-	1500	ms
$T_{ac\_on\_delay}$	Delay from input being applied to all output voltages being within regulation.	-	-	3000	ms
T_{vout_holdup}	Time 12V stays within regulation after loss of input.	11	-	-	ms
T_{pwok_holdup}[2]	Delay from input loss to de-assertion of PWOK	5	10	-	ms
$T_{pson\_off\_delay}$	Delay from PSON# de-asserted to power supply turning off	-	-	5[5]	ms
$T_{pson\_on\_delay}$	Delay from PSON# active to output voltages within regulation limits.	5	-	400	ms
T_{pson_pwok}	Delay from PSON# deactivate to P_{WOK} being de-asserted.	-	-	3	ms
T_{pwok_on}	Delay from output voltages within regulation limits to PWOK asserted at turn on.	380	-	420	ms
T_{pwok_off}[2]	Delay from PWOK de-asserted to output voltages dropping out of regulation limits based on input lost condition.	1	-	6[4]	ms
	Delay from PWOK de-asserted to output voltages dropping out of regulation limits based on PSON signal de-asserted condition.	1[5]	-	2[5]	ms
T_{pwok_low}	Duration of PWOK being in the de-asserted state during an off/on cycle using input or the PSON# signal.	100	-	-	ms
T_{SB_vout}	Delay from $12V_{SB}$ being in regulation to outputs being in regulation at input turn on.	50	-	1000	ms
T_{12VSB_holdup}	Time the $12V_{SB}$ output voltage stays within regulation after loss of input.	70	-	-	ms
T_{vinok_on}[3]	Delay from $12V_{SB}$ within regulation limits to assertion of VINOK	0	-	50	ms
T_{vinok_off}[3]	Time from loss of input to de-assertion of VINOK	1000	-	4000	us

Note 1 - T_{off_latch} flow diagram is shown in T_{off_latch} Flow Diagram.
Note 2 - The T_{pwok_holdup} = 10ms and T_{pwok_off} = 1ms, are the default values in the power supply unit when it's being energized, however the system now can configure the warning time established by T_{pwok_off} to have a different value please refer to PWOK Signal Timing Requirements.
Note 3 - Additional logic dependencies are described in T_{vinok} Assertion Logic.
Note 4 - T_{pwok_off} can be configure from 1ms (default) to a maximum of 6ms, refer to PWOK Signal Timing Requirements for more details.
Note 5 - Using minimum capacitance specified in table 3 and 2% of rated load.

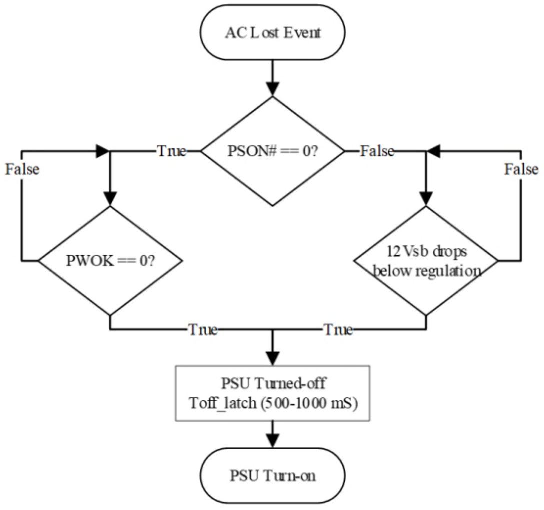
SECTION 2 ELECTRICAL SPECIFICATIONS

2.4 System Timing Diagram

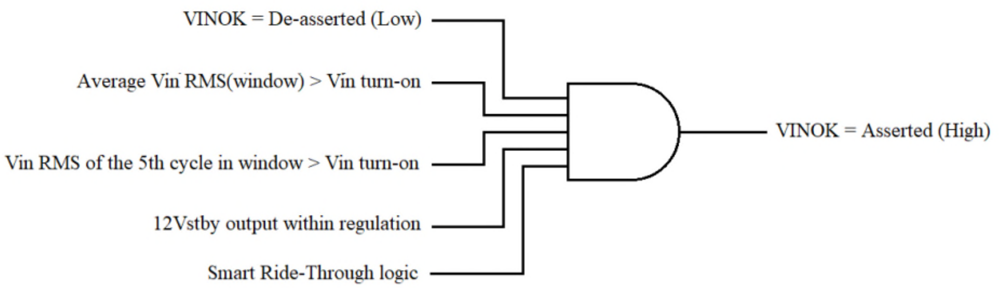


SECTION 2 ELECTRICAL SPECIFICATIONS

T_{off_latch} Flow Diagram



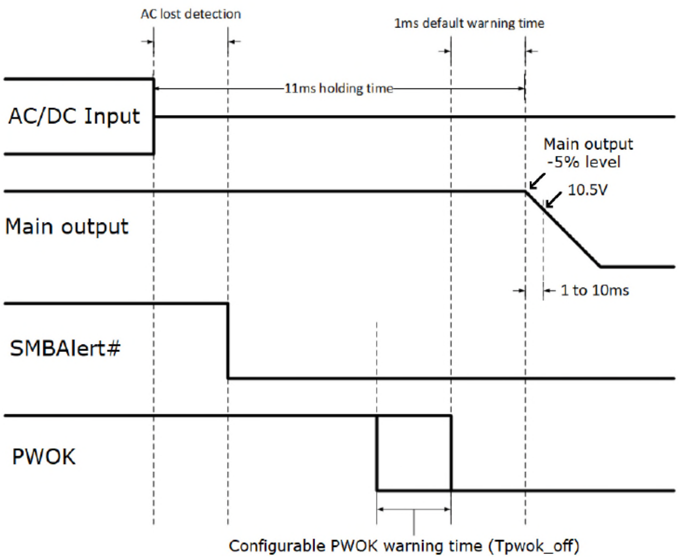
T_{VINOK} Assertion Logic



SECTION 2 ELECTRICAL SPECIFICATIONS

PWOK Signal Timing Requirements

Timing requirements when the power supply is being energized (AC/DC is applied), however the warning time established by T_{pwok_off} can be configurable via PMBus command MFR_PWOK_WARNING_TIME (F0h) using linear format it is recommended to use 1ms steps and the power supply can guarantee at least the minimum warning time configured, it is recommended to have a jitter no more than 1.5 ms. Below shows the timing diagram. T_{pwok_off} value can return to default after an AC/DC input cycle only. The figure below shows the timing diagram. T_{pwok_off} value can return to default after an AC/DC input cycle only with a complete power supply power off (indicator LED off and secondary side MCU de-energized).



The main output has a slope decay of 1-10 ms from 11.40 V to 10.5 V when going down using a 2% loading condition and the minimum capacitance across the main output as defined in table 3.

SECTION 2 ELECTRICAL SPECIFICATIONS

2.5 CSU2400AT-3-3M0 Performance Curves

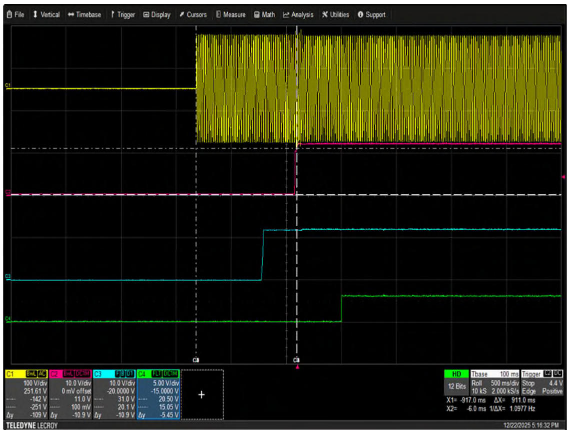


Figure 1: CSU2400AT-3-3M0 Turn-On Delay via AC Mains
Vin = 90 VAC Load: I_O = 114.75 A I_{SB} = 3.0 A
Ch 1: AC Mains Ch 2: V_O Ch 3: V_{SB} Ch 4: PWOK

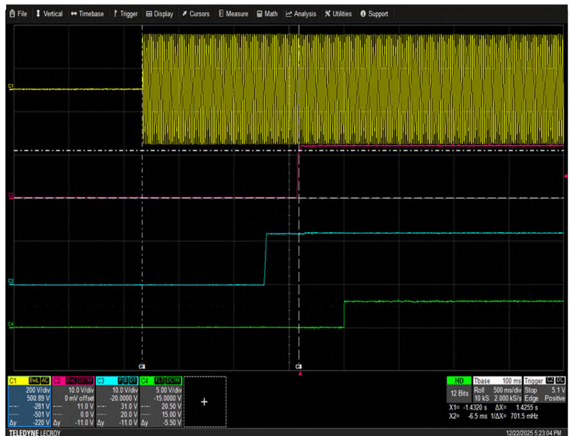


Figure 2: CSU2400AT-3-3M0 Turn-On Delay via AC Mains
Vin = 180 VAC Load: I_O = 196.72 A I_{SB} = 3.0 A
Ch 1: AC Mains Ch 2: V_O Ch 3: V_{SB} Ch 4: PWOK

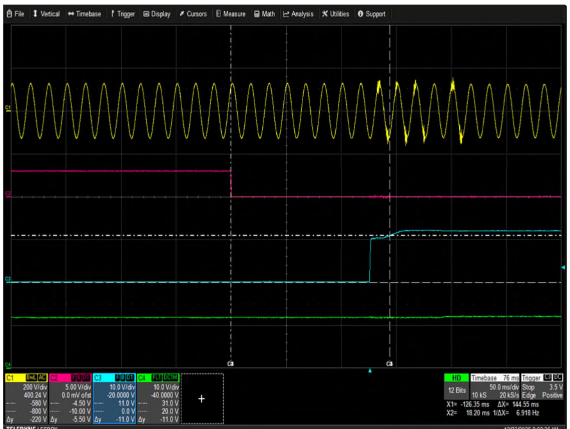


Figure 3: CSU2400AT-3-3M0 Turn-On Delay via PSON
Vin = 90 VAC Load: I_O = 114.75 A I_{SB} = 3.0 A
Ch 1: AC Mains Ch 2: PSON Ch 3: V_O Ch 4: V_{SB}

Figure 4: CSU2400AT-3-3M0 Turn-On Delay via PSON
Vin = 180 VAC Load: I_O = 196.72 A I_{SB} = 3.0 A
Ch 1: AC Mains Ch 2: PSON Ch 3: V_O Ch 4: V_{SB}

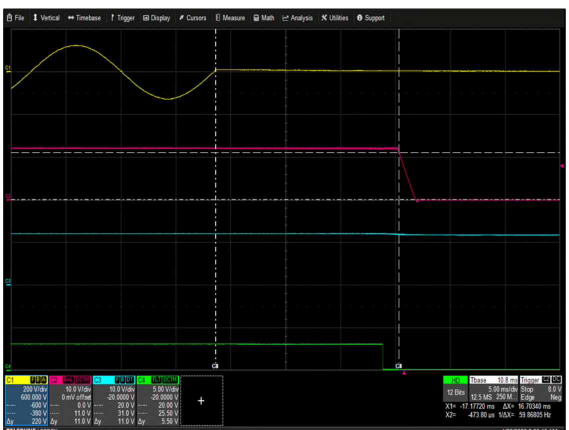


Figure 5: CSU2400AT-3-3M0 Hold-Up Time
Vin = 90 VAC Load: Io = 114.75 A I_{SB} = 3.0 A
Ch 1: AC Mains Ch 2: V_O Ch 3: V_{SB} Ch 4: PWOK

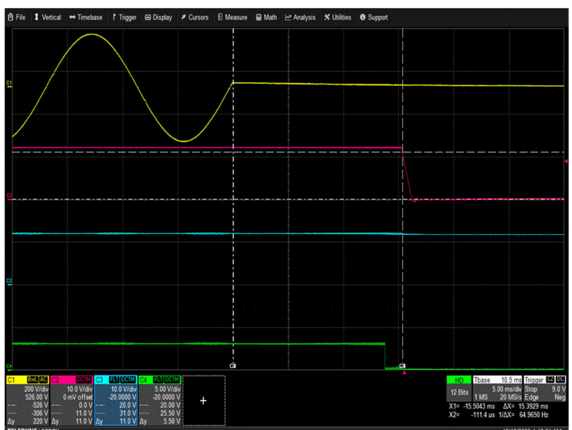


Figure 6: CSU2400AT-3-3M0 Hold-Up Time
Vin = 180 VAC Load: Io = 196.72 A I_{SB} = 3.0 A
Ch 1: AC Mains Ch 2: V_O Ch 3: V_{SB} Ch 4: PWOK

SECTION 2 ELECTRICAL SPECIFICATIONS

CSU2400AT-3-3M0 Performance Curves

Figure 7: CSU2400AT-3-3M0 Output Voltage Startup Characteristic
Vin = 180 VAC Load: Io = 196.72 A I_{SB} = 3.0 A
Ch 1: V_O

Figure 8: CSU2400AT-3-3M0 Turn Off Characteristic via PSON
Vin = 180 VAC Load: Io = 196.72 A I_{SB} = 3.0 A
Ch 2: PSON Ch 3: V_O Ch 4: PWOK

Figure 9: CSU2400AT-3-3M0 Transient Response - V_O Deviation
196.72 A to 78.69 A (100% to 40%) 2.5 A/µS slew rate Vin = 240 VAC
Ch 2: V_O Ch 3: I_O Output Cap: 2200 µF

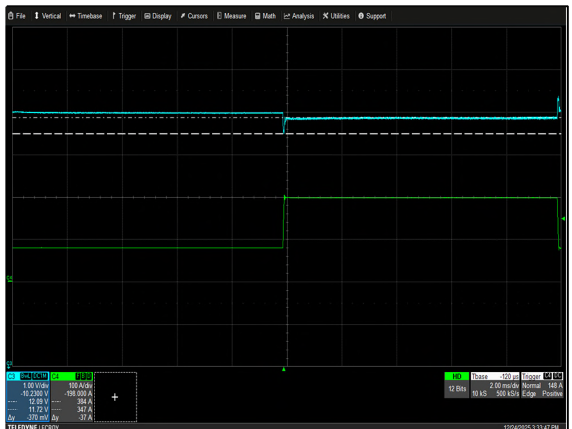


Figure 10: CSU2400AT-3-3M0 Transient Response - V_O Deviation
78.68 A to 196.72 A (40% to 100%) 2.5 A/µS slew rate Vin = 240 VAC
Ch 2: V_O Ch 3: I_O Output Cap: 2200 µF

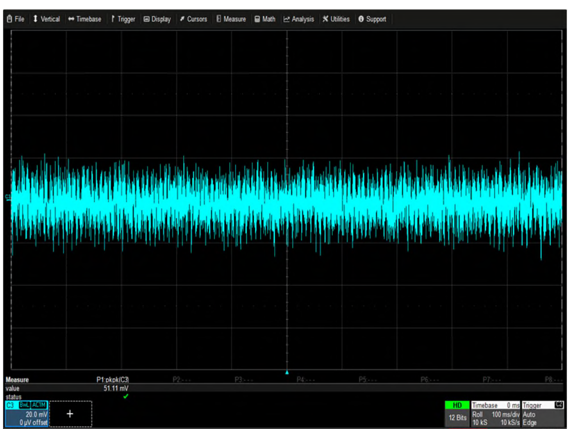


Figure 11: CSU2400AT-3-3M0 Ripple and Noise Measurement
Vin = 180 VAC Load: Io =196.72 A I_{SB} = 3.0 A
Ch 3: V_O

Figure 12: CSU2400AT-3-3M0 Inrush Current
Vin = 264 VAC Load: Io = 0 A Turn on at 90 deg
Ch 1: V_{IN} Ch 3: I_{IN}

SECTION 2 ELECTRICAL SPECIFICATIONS

CSU2400AT-3-3M0 Performance Curves

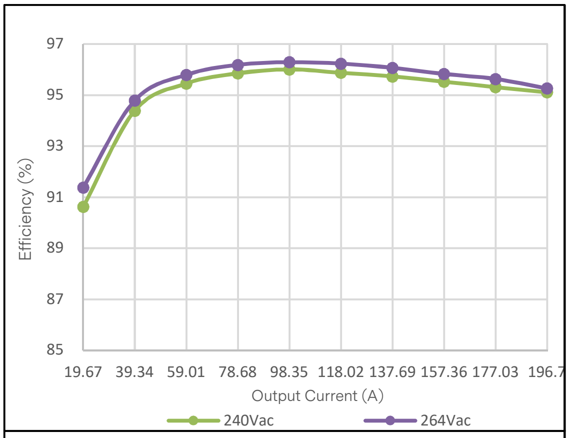


Figure 13: CSU2400AT-3-3M0 Efficiency Curve @ 25ºC

Loading: I_{o_main} = 10% increment to $I_{o,max}$

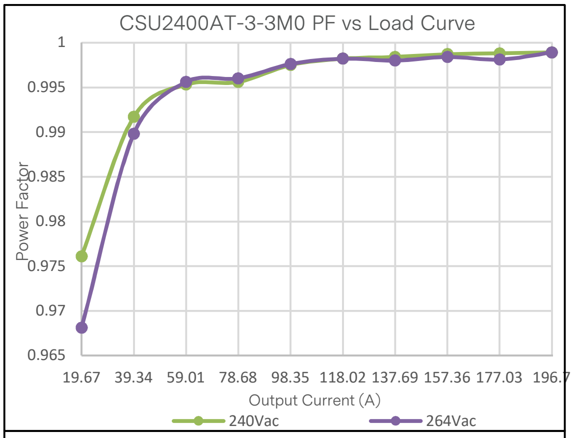


Figure 14: CSU2400AT-3-3M0 PF vs Load Curve

Loading: I_{o_main} = 10% increment to $I_{o,max}$

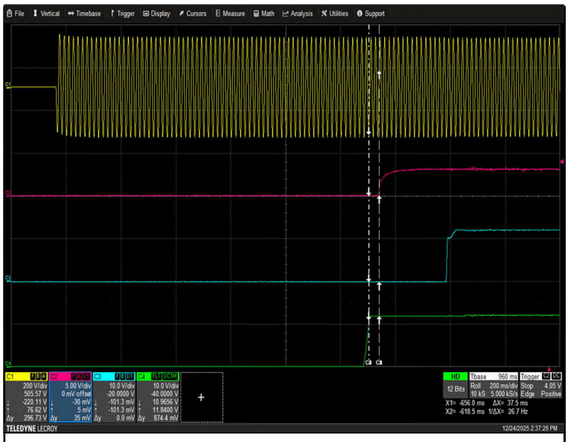


Figure 15: CSU2400AT-3-3M0 VINOK Assert Characteristic
Vin = 240 VAC Load: Io = 196.72 A I_{SB} = 3.0 A
Ch 1: AC Mains Ch 2: VINOK Ch 3: V_O Ch 4: V_{SB}

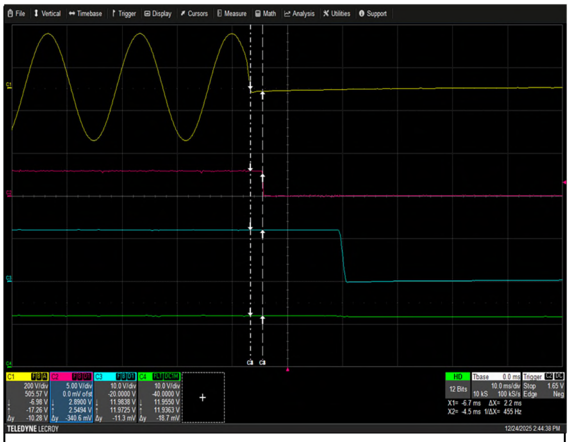


Figure 16: CSU2400AT-3-3M0 VINOK De-assert Characteristic
Vin = 240 VAC Load: Io = 147.5 A I_{SB} = 3.0 A
Ch 1: AC Mains Ch 2: VINOK Ch 3: V_O Ch 4: V_{SB}

SECTION 2 ELECTRICAL SPECIFICATIONS

2.6 Protection Function Specifications

Input Fuse

CSU2400AT-3-3M0 power supply have one fuse on the line (Hot) wire of the AC input. The line fusing is acceptable for all safety agency requirements. The input fuse is a High breaking capacity fast blow type. AC/DC inrush current can not cause the AC/DC line fuse to blow under any conditions. All protection circuits in the power supply can not cause the AC/DC fuse to blow unless a component in the power supply has failed. This includes DC output load short conditions.

Output Under Voltage Protection (UVP)

The power supply under voltage protection is locally sensed and hardware based. The power supply will shutdown and latch off after an under-voltage condition occurs. This latch can be cleared by toggling the PSON# signal or by an AC power interruption. The values are measured at the output of the power supply's connectors. The voltage will never trip any higher than the maximum levels when measured at the power connector.

Parameter	Min	Nom	Max	Unit
Main Output Overvoltage	9.5	-	10	V
Standby Output Overvoltage	9.5	-	10	V

Output Over Voltage Protection (OVP)

The OVP is locally sensed and hardware based. The power supply will shutdown and latch off after an over voltage condition occurs. The latch can be cleared by toggling the PSON signal or the input power interruption. The values are measured at the output of the power supply's connectors.

The voltage can not exceed the maximum levels when measured at the power connectors of the power supply connector during any single point of fail. The voltage can not trip any lower than the minimum levels when measured at the power connector. $12V_{SB}$ will be auto-recovered after removing the OVP limit.

Parameter	Min	Nom	Max	Unit
Main Output Overvoltage	13.6	-	14.5	V
Standby Output Overvoltage	14.0	-	15.0	V

Short Circuit Protection (SCP)

A short circuit applied to any output during start-up or while running will not cause any damage to the power supply (connectors, components, PCB traces, etc.), even when output remains shorted. Short circuit conditions applied to any of the outputs including the standby may generate very high peak currents because of the time delay until the output will latch off or PSU enters hiccup mode of operation.

When the standby output is shorted, the output will go into hiccup mode.

The short circuit impedance is less than 10 mohm for the main output and less than 200 mohm for standby output.

Over Temperature Protection (OTP)

The power supply is protected against over temperature conditions caused by loss of fan cooling or excessive ambient temperature.

In an OTP condition the PSU will shutdown. OT warning SMBAlert# assertion always precede the OTP shutdown.

When the power supply temperature drops to within specified limits, the power supply can restore power automatically, while the $12V_{SB}$ remains always on. The OTP circuit have built in margin such that the power supply will not oscillate on and off due to temperature recovering condition. The OTP trip temperature level is at least $4^{O}C$ higher than Over Temperature Warning threshold level.

The Over Temperature Protection threshold can be configurable.

SECTION 2 ELECTRICAL SPECIFICATIONS

Model Number	Parameter (Inlet Air Temperature)	Min	Max	Unit
CSU2400AT-3-3M0	Over Temperature Warning (OTW) Over Temperature Shutdown (OTP)	60 65		°C °C

Over Current Protection (OCP)

CSU2400AT-3-3M0 includes internal current limit circuitry to prevent damage in the event of overload or short circuit. It has over current protection (OCP), over current warning (OCW), and over power protection (OPP) limits as defined in table below. They are defined to protect the PSU and to allow peak current to power the system without the PSU shutting down. Fast OCW and slow OCW levels are defined to assert SMBAlert to allow the system to throttle power to protect the PSU and also to allow peak current draws by the system. When OCP trips, it will shutdown and latch off the PSU. The latched PSU is cleared by an AC power cycle or PSON recycle. The power supply can not be damaged from repeated power cycling in this condition. $12V_{SB}$ is auto-recovered after removing OCP limit.

High line:

Parameter	Thresholds		Timing		Protection Mode
	Min	Max	Min	Max	
Primary power limit	344 A	-	-	-	Immediately into Constant Current mode
V_O Output Constant Current mode	314 A		2 ms		Constant Current mode
V_O Output Fast Overcurrent Warning	311 A	-	1 ms	-	SMBAlert
V_O Output Slow Overcurrent Warning	233 A	-	10 ms	-	SMBAlert
V_O Output Slow Overcurrent Protection	233 A	-	25 ms	-	Foldback then latch after min timing
V_SB Output Overcurrent Protection	3.65 A	-	100 ms	-	Shut down and hiccup mode

Low line:

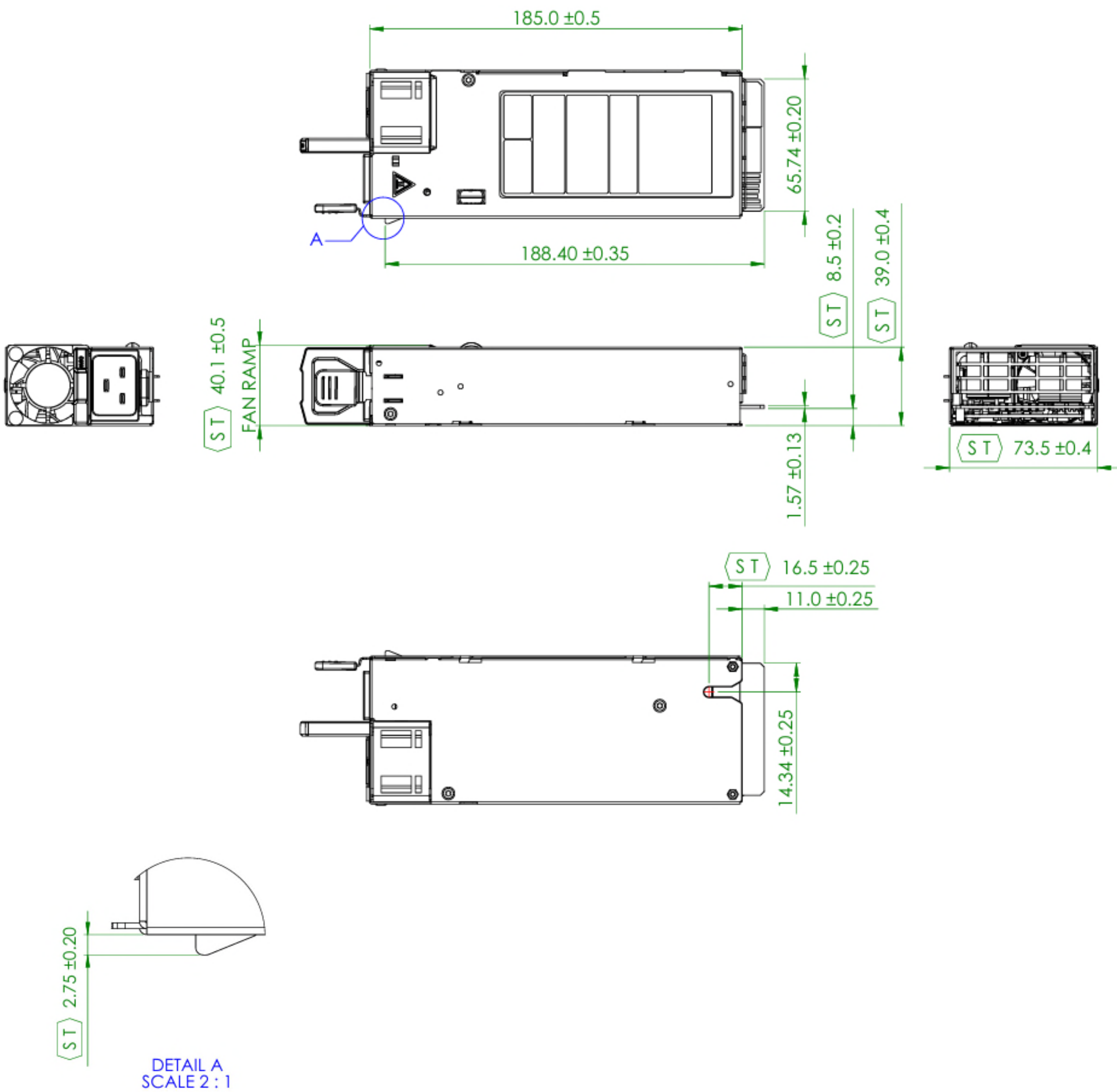
Parameter	Thresholds		Timing		Protection Mode
	Min	Max	Min	Max	
Primary power limit	200 A	-	-	-	Immediately into Constant Current mode
V_O Output Constant Current mode	183 A		2 ms		Constant Current mode
V_O Output Fast Overcurrent Warning	181 A	-	1 ms	-	SMBAlert
V_O Output Slow Overcurrent Warning	136 A	-	10 ms	-	SMBAlert
V_O Output Slow Overcurrent Protection	136 A	-	25 ms	-	Foldback then latch after min timing
V_SB Output Overcurrent Protection	3.65 A	-	100 ms	-	Shut down and hiccup mode

Standby:

Parameter	Thresholds		Protection Mode
	Min	Max	
Primary power limit	3.6 A	4.4 A	Hiccup mode

SECTION 3 MECHANICAL SPECIFICATIONS

3.1 Mechanical Outlines



SECTION 3 MECHANICAL SPECIFICATIONS

3.2 Mechanical Data

Table 5. Mechanical Data	
Dimensions (L x W x D)	7.28” x 2.89” x 1U (185 mm x 73.5 mm x 40 mm)
Weight	0.9 kg / Unit 9.8 kg / Carton 315 kg / Pallet
Cooling	Built in fan

3.3 Unit Packaging Requirement

Packing Dimensions(L x W x D)	Product: 220 mm x 78 mm x 40 mm Carton: 345 mm x 298 mm x 236 mm Pallet: 1220 mm x 1016 mm x 870 mm
Packing Quantities	5 Units / Tray 10 Units / Carton 10 Carton / Layer 30 Carton / Pallet 300 Units / Pallet
Packaging Weight	0.9 kg / Unit 9.8 kg / Carton 315 kg / Pallet

SECTION 3 MECHANICAL SPECIFICATIONS

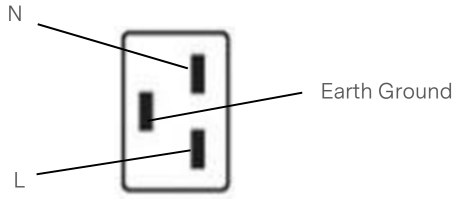
3.4 Connector Definitions

AC Input Connector

Line

Neutral

Earth Ground



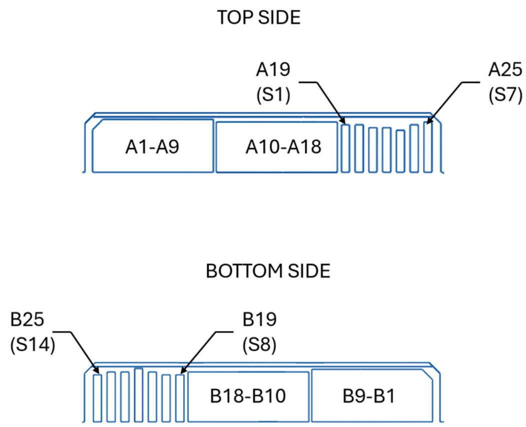
Output Connector - Power Blades

A1-A9 (P1-P3) – Main Output Return

A13-A18 (P5-P6) – Main Output (V_O)

B1-B9 (P7-P9) – Main Output Return

B13-B18 (P11-P12) – Main Output (V_O)



View from power supply output connector end

Output Connector - Control Signals

A19 (S1) – SDA

A20 (S2) – SCL

A21 (S3) – PSON#

A22 (S4) – SMBAlert#

A23 (S5) – -VSENSE/PS_KILL

A24 (S6) – +VSENSE

A25 (S7) – PWOK

B19 (S8) – A0 (SMBus Address)

B20 (S9) – A1 (SMBus Address)

B21 (S10) – $12V_{SB}$

B22 (S11) – CR_BUS

B23 (S12) – IShare

B24 (S13) – IMON

B25 (S14) – VINOK

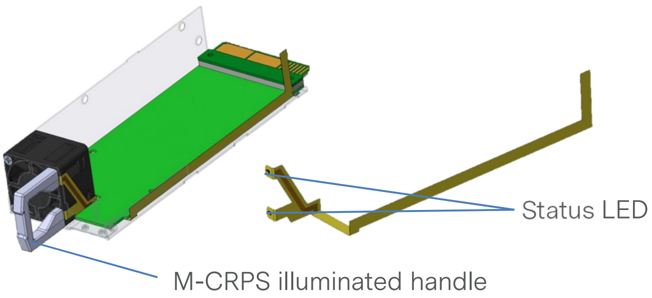
SECTION 3 MECHANICAL SPECIFICATIONS

3.5 Power / Signal Mating Connectors and Pin Types

Table 6. Mating Connectors for CSU2400AT-3-3M0		
Reference	On Power Supply	Mating Connector or Equivalent
AC Input Connector	IEC320-C20	IEC320-C19
Output Connector	Card-edge	FCI Amphenol 10147875-001LF

SECTION 3 MECHANICAL SPECIFICATIONS

3.6 LED Indicator Definitions



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

Conditions	LED Status
AC present, main output ON, standby output ON	Solid Green
Main output OFF, standby output ON	Solid Green
AC input under voltage, main output OFF, standby output OFF	OFF
Any kind of warning (over current/over temperature/over voltage/fan)	Solid Green
Cold redundant enabled	Solid Green
Any kind of fault (output over voltage/over current/over temperature/ output under voltage, standby output voltage/standby output under voltage)	Amber PWM (2 s ON; 1 s OFF)
Fan Fault	Amber PWM (2 s ON; 1 s OFF)
Firmware upgrade	Blinking Green at 4 Hz

SECTION 4 ENVIRONMENTAL SPECIFICATIONS

4.1 EMC Immunity

CSU2400AT-3-3M0 power supply is designed to meet the following EMC immunity specifications.

Table 7. EMC Immunity Specifications

Test Items	Standard	Test Level	Criteria[1]
Conducted Emissions	EN 55032, FCC CFR 47 Part 15 Subpart B	Class A. 150 K to 30 MHz	6dB Margin, average
Radiated Emissions	EN 55032, FCC CFR 47 Part 15 Subpart B	Class A. 30 M to 1 GHz	6dB Margin, average
Harmonic Current Emissions	IEC 61000-3-2	-	-
Voltage Fluctuations	IEC 61000-3-3	-	-
Electro Static Discharge (ESD) Immunity	IEC 61000-4-2	8 kV contact, 15 kV air	A
Radiated RF EM Fields Susceptibility	IEC 61000-4-3	10 V/m	A
Electrical Fast Transients (EFT) / Bursts	IEC 61000-4-4	+/-2 kV	A
Surges - Line to Line (DM) and Line to GND (CM)	IEC 61000-4-5	2 kV DM, 3 kV CM 2.5 kV DM (design margin) 3.5 kV CM (design margin)	B
Conducted Immunity	IEC 61000-4-6	10 Vrms 0.15 MHz – 10 MHz 3vrms 10 MHz – 30 MHz 3 V to 1 V 30 MHz – 80 MHz 1 V	A
Voltage Dips & Sags	IEC 61000-4-11	>95% for 10 ms ≤30% for 500 ms >95% for 500 ms	C
Power Frequency Magnetic Field	IEC 61000-4-8	1 A/m	A

Note 1 - Performance criteria are based on EN55032. According to the standards, performance criteria are defined as following:

A - Normal performance during and after the test
B - Temporary degradation, self-recoverable
C - Temporary degradation, operator intervention required to recover the operation
D - Permanent damage

SECTION 4 ENVIRONMENTAL SPECIFICATIONS

4.2 Safety Certifications

The CSU2400AT-3-3M0 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 8. Safety Certifications for CSU2400AT-3-3M0 Power Supply

Standard	Agency	Description
IEC 60950, IEC 62368, UL/cUL	CE	European Requirements
CB Certificate		All CENELEC Countries
CQC Approval		China Requirements
KC		Korea Certification
EAC		Russia Requirements
BIS		India Requirements
BSMI		Taiwan Requirements
CE Mark		ROHS

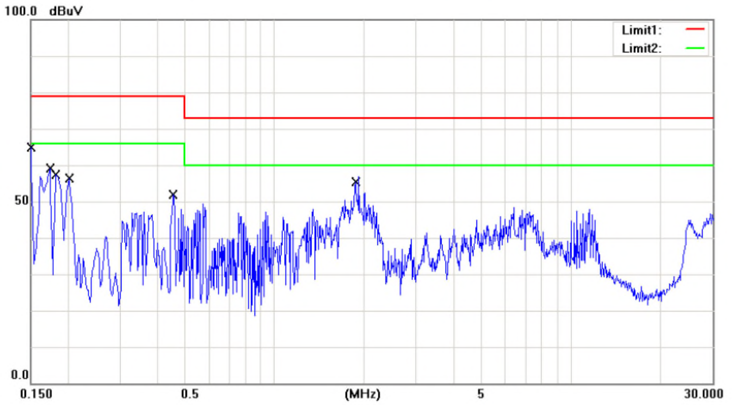
SECTION 4 ENVIRONMENTAL SPECIFICATIONS

4.3 EMI Emissions

The CSU2400AT-3-3M0 power supply has been designed to comply with the Class A limits of EMI requirements of FCC CFR 47 Part 15 Subpart B and EN55032 for emissions and relevant sections of EN55032: 2011 for immunity. The unit is tested at 2400 W 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 CSU2400AT-3-3M0 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.

Sample of EN55032 conducted EMI measurement at 230 VAC input.

Note: Red Line refers to Advanced Energy's Quasi Peak margin, which is 6 dB below the CISPR international limit.
Green Line refers to Advanced Energy's Average margin, which is 6 dB below the CISPR international limit.

Conducted EMI emissions specifications of the CSU2400AT-3-3M0 power supply:

Parameter	Model	Symbol	Min	Typ	Max	Unit
FCC Part 15, class A	All	Margin	-6	-	-	dB
CISPR 32 (EN55032), class A	All	Margin	-6	-	-	dB

SECTION 4 ENVIRONMENTAL SPECIFICATIONS

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 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.

SECTION 4 ENVIRONMENTAL SPECIFICATIONS

4.4 Short-Term Excursion Temperature

The CSU2400AT-3-3M0 Short-Term Excursion Temperature is shown in the table below.

Table 9. Power Supply Thermal Test Condition

Model	Output Power	Altitude	Maximum Inlet Temperature	Maximum Exhaust Temperature	Maximum Touch Surface Temperature
CSU2400AT-3-3M0[1]	2400 W	950 m	55^{O}C	75^{O}C[2]	75^{O}C

Note 1 - Power supply meets Tier 2 level. The temperature limit for the components will be based on their maximum Tj -10^{O}C for components like power semiconductors, magnetics, bulk capacitors, aluminum polymer capacitors at the output of the power supply and PCB.
Note 2 - Power supply will need to have a mylar coating in all the metal parts in the rear part of the chassis when the temperature exceeds 70^{O}C.

4.5 Forced Air Cooling

The CSU2400AT-3-3M0 includes internal cooling fans as part of the power supply assembly to provide forced air-cooling to maintain and control the 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.

SECTION 4 ENVIRONMENTAL SPECIFICATIONS

4.6 Storage and Shipping Temperature

The CSU2400AT-3-3M0 power supply can be stored or shipped at temperatures between -40°C to +70°C and relative humidity from 5% to 95% non-condensing.

4.7 Altitude

The CSU2400AT-3-3M0 power supply is certified for safety spacing requires for up to 3,050 meters altitude. The power supply will not be damaged when stored at altitudes of up to 15,200 meters above sea level.

4.8 Humidity

The CSU2400AT-3-3M0 power supply can operate in a relative humidity up to 85% non-condensing. The power supply can be stored in relative humidity up to 95% non-condensing.

4.9 Vibration

The CSU2400AT-3-3M0 power supply is performed per power supply vibration test procedure:

Non-operating random vibration

Acceleration	3.13		gRMS
Frequency Range	5 - 500		Hz
Duration	10		Mins/side
Direction	3 resonant points		
PSD Profile	FREQ (Hz)	SLOPE (db/oct)	PSD (g²/Hz)
	5	/	0.01
	20	/	0.02
	500	/	0.02

Operating random vibration

Acceleration	1.446		gRMS
Frequency Range	7 - 800		Hz
Duration	30		Mins/side
Direction	All 6 sides except AC connection		
PSD Profile	FREQ (Hz)	SLOPE (db/oct)	PSD (g²/Hz)
	7	/	0.00015
	20	/	0.014
	140	/	0.014
	312	/	0.000065
	400	/	0.000035
	600	/	0.000035
	800	/	0.000023

SECTION 4 ENVIRONMENTAL SPECIFICATIONS

4.10 Shock

The CSU2400AT-3-3M0 power supply is performed per power supply shock test procedure: :

Non-operating square wave shock

Acceleration	40	G
Duration	200	Inch/Sec
Pulse	Square wave	
Number of Shock	1 shock on each of 6 faces	

Non-operating half-sine shock

Acceleration	142	G
Duration	2	mSec
Pulse	Half sine wave	
Number of Shock	1 shock on each of 6 faces	

Operating half-sine shock

Acceleration	82	G
Duration	200	Inch/Sec
Pulse	Half-Sine wave	
Number of Shock	1 shock on each of 6 faces	

SECTION 5 POWER AND CONTROL SIGNAL DESCRIPTIONS

5.1 AC Input Connector

This connector supplies the AC Mains to the CSU2400AT-3-3M0 power supply.

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

5.2 Output Connector – Power Blades

These pins provide the main output for the CSU2400AT-3-3M0 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 CSU2400AT-3-3M0 power supply.

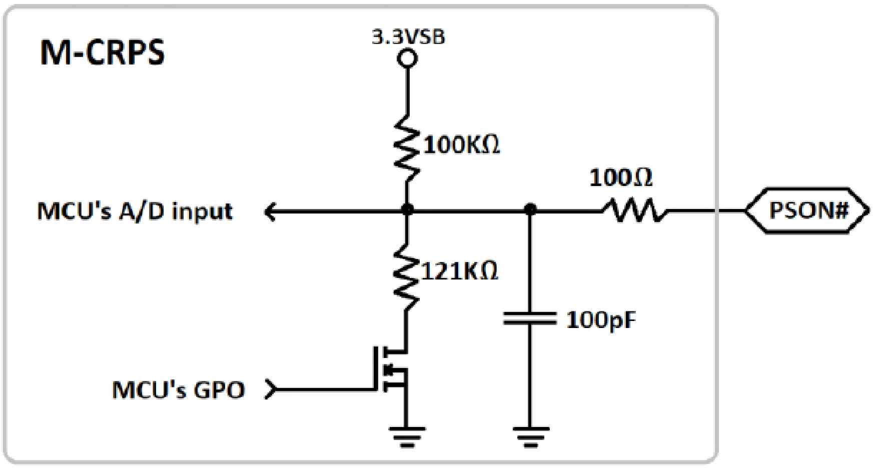
A1-A9 (P1-P3) – Main Output Return
A13-A18 (P5-P6) – Main Output (V_O)
B1-B9 (P7-P9) – Main Output Return
B13-B18 (P11-P12) – Main Output (V_O)

5.3 Output Connector – Control Signals

The CSU2400AT-3-3M0 power supply contains a 14 pins control signal header providing an analogue control interface, standby power and I^2C interface signal connections.

PSON# - (Pin A21,S3)

This power supply have a PSON# signal to remotely turn ON/OFF the power supply. It can be configured via firmware to work as a two-state (default) or multi-state PSON# signal based on the configuration provided by the configuration file. To accomplish the two/multi-state modes the power supply incorporates the circuit below.



Note 1 - Applying a logic 1 to the MOSFET will configure the PSON# input signal as multi-state.
Note 2 - Applying a logic 0 to the MOSFET will configure the PSON# input signal as two-state.
Note 3 - $3.3V_{SB}$ in the voltage divider are take from a precision voltage reference.

SECTION 5 POWER AND CONTROL SIGNAL DESCRIPTIONS

The specifications for these two different configurations are described in the following subsections.

Two-State Signal

When the PSON# signal is configured as two-state, it is active low to turn ON the +12V main power output. When this signal is not pulled low by the system, or left open, the +12V main output is turned OFF while the $12V_{SB}$ output still remains ON. This signal is pulled to a standby voltage by a pull-up resistor internal to the power supply. The table below lists the required characteristics of the PSON# signal when configured as two-state input.

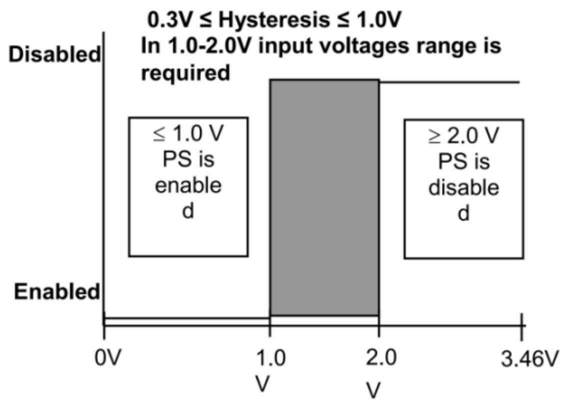


Table 10. Two-state PSON# Signal Characteristics		
Signal Type	Accepts an open collector/drain input from the system. Pull-up to $3.3V_{SB}$ located in power supply.	
PSON# = Low	ON	
PSON# = High or Open	OFF	
	MIN	MAX
Logic level low (power supply ON)	0 V	1 V
Logic level high (power supply OFF)	2 V	3.46 V
Source current, Vpson = low	-	4 mA
Power off delay: Tpson_off_delay	-	5 ms
Power up delay: Tpson_on_delay	5 ms	400 ms
PWOK delay: Tpson_pwok	-	5 ms

SECTION 5 POWER AND CONTROL SIGNAL DESCRIPTIONS

Multi-State Signal

When configured as multi-state input, the PSON# signal is able to detect logic 0, logic 1 and high impedance (pin floating or open) and additional 3 states. The thresholds to detect these three states are depicted in the following figure.

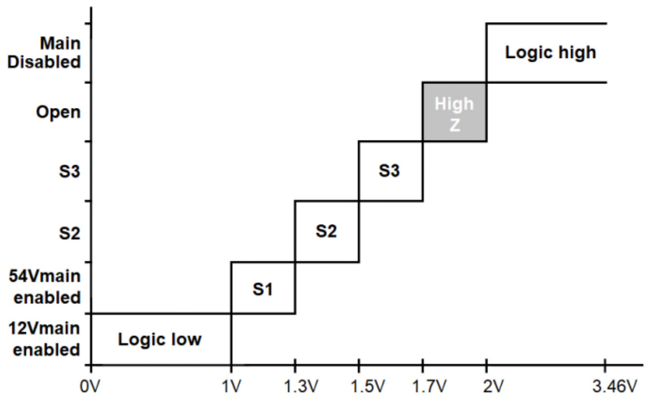


Table 11. Multi-state PSON# Voltage Ranges Definition

State	Power supply must detect PSON# voltage within this range			System must set PSON# voltage within this range			12V M-CRPS Main Output
	MIN(V)	NOM(V)	MAX(V)	MIN(V)	NOM(V)	MAX(V)	
Logic low	0	-	<1	0	-	0.95	Main output ON, $12V_{SB}$ ON
S1	1	1.15	<1.3	1.03	1.15	1.27	Main output OFF, $12V_{SB}$ ON
S2	1.3	1.4	<1.5	1.33	1.4	1.47	Main output OFF, $12V_{SB}$ ON
S3	1.5	1.6	<1.7	1.53	1.6	1.67	Main output OFF, $12V_{SB}$ OFF
Open	1.7	1.85	<2	1.73	1.85	1.87	$12V_{SB}$ ON
Logic high	2	-	3.46	2.05	-	3.46	Main output OFF, $12V_{SB}$ ON

SECTION 5 POWER AND CONTROL SIGNAL DESCRIPTIONS

PSON# stage designed to follow the logic as shown in the table below for assertion and de-assertion states when used in Multi-state PSON# mode.

Table 12. PSON# Transition States When Using Multi-state Mode

No.	VINOK	System State Of PSON#	PSON# Transition State	PSU Main Output State
1	High	Initialization (HI-Z, HIGH)	Hi-Z, High	Remain OFF
2	High	Low	Low	Stays ON
3			High	Turns OFF
4			HI-Z	Stays ON
5	High	High	Low	Turn ON
6			High	Remain OFF
7			HI-Z	Remain OFF
8	High	HI-Z	Low	Turn ON if OFF || Remain ON
9			High	Turn Off if On || Remain OFF
10			HI-Z	Preserve Last State
11	Low	Low	Low	Remain ON until PWOK drops
12			High	Turn off
13			HI-Z	Remain ON until PWOK drops
14	Low	High	Low	Turn ON until PWOK drops
15			High	Remain OFF
16			HI-Z	Remain OFF
17	Low	HI-Z	Low	Turn ON until PWOK drops
18			High	Turn Off if On || Remain OFF
19			HI-Z	Preserve Last State

SECTION 5 POWER AND CONTROL SIGNAL DESCRIPTIONS

SMBALERT# - (Pin A22, S4)

SMBALERT indicates that the power supply is experiencing a problem that the user should investigate. This signal is asserted due to critical events or warning events as configured in the configuration file. The signal will activate in the case of critical component temperature reaching a warning threshold, general failure, over-current, over-voltage, under-voltage, failed fan. This signal may also indicate the power supply is reaching its end of life or is operating in an environment exceeding the specified limits. This SMBAlert# signal is to be asserted in parallel with LED color code selected in the configuration file.

Table 13. SMBAlert# Signal Characteristics

Signal Type	Open collector / drain output from power supply. Pull-up to 3.3VSB located in the system.	
Alert# = High	OK	
Alert# = Low	Power alert to system	
	MIN	MAX
Logic level low voltage, Isink = 4 mA	0 V	0.4 V
Logic level high voltage, Isink = 50 uA		3.46 V
Sink current, alert# = low		4 mA
Sink current, alert# = high		50 uA

-VSENSE/PS_KILL and +VSENSE - (Pins A23, S5) (A24,S6)

The power supply has a remote sensing pair called +VSENSE for the positive terminal (RS+) and -VSENSE for the negative terminal (RS-) to compensate voltage droops at the point of load. The Return Sense (RS-) pin has dual purpose acting as a PS_KILL signal also as described below:

1. It is able to measure the most negative voltage at the load to regulate it at the point of load.
2. It is able to work as a PS_KILL signal when the power supply is being extracted or inserted without removing the AC/DC cord, shutting down the main output of the power supply fast enough or preventing it from turning ON until PS_KILL contacts with the system, thus preventing arcing at the connector, the RS-/PS_KILL pin has a shorter length in the card edge than other signals to allow this functionality. The $12V_{SB}$ output remains ON as long as input voltage stays within the specified range.

Table 14. –VSENSE/PS_KILL and +VSENSE Signal Parameters

Parameter	Specification
Delay between RS-/PSKILL signal being disconnected and PSU main output's ramping down	<100 us
Maximum DC resistance of remote sensing wires/traces (each)	2.5 ohm
Maximum voltage droop compensation	±200 mV

PWOK - (Pin A25,S7)

PWOK is a power OK output signal and will be pulled HIGH by the power supply to indicate that all the outputs are within the regulation limits of the power supply. When any output voltage falls below regulation limits or when AC power has been removed for a time sufficiently long so that power supply operation is no longer guaranteed, PWOK will be de-asserted to a LOW state. See the table below for a representation of the timing characteristics of PWOK. The start of the PWOK delay time will be inhibited as long as any power supply output is in current limit.

SECTION 5 POWER AND CONTROL SIGNAL DESCRIPTIONS

Table 15. PWOK Signal Characteristics		
Signal Type	Open collector / drain output from power supply. Pull-up to 3.3VSB located in the system.	
PWOK = High	Power OK	
PWOK = Low	Power Not OK	
	MIN	MAX
Logic level low voltage, Isink = 400uA	0 V	0.4 V
Logic level high voltage, Isource = 200uA	2.4 V	3.46 V
Sink current, PWOK = low	-	400 uA
Source current, PWOK = high	-	2 mA
PWOK delay: Tpwok_on	380 ms	420 ms
PWOK rise and fall time	-	100 us
Power down delay: Tpwok_off	1 ms	-
Any PSU fault to PWOK deassertion delay	-	100 us

$12V_{SB}$– (Pin B21,S10)

This pin provides the standby output for the CSU2400AT-3-3M0 power supply. The Standby Output (V_{SB}) and the GND pin are the positive and negative rails, respectively, of the V_{SB} of the CSU2400AT-3-3M0 power supply.

CR_BUS - (Pin B22,S11)

This is a tri-state output signal of the power supply used to communicate a fault or over current has occurred in one of the power supplies. This is used to power on all the power supplies in the system via the CR_BUS. When the signal is pulled high, it allows all power supplies in cold standby mode to go into cold standby state when the load share is light enough. When the signal is left open on all power supplies, it forces all cold standby power supplies into the ON.

SECTION 5 POWER AND CONTROL SIGNAL DESCRIPTIONS

ISHARE - (Pin B23, S12)

12V load share is a single wire bus signal used to help equalize the output current from two or more power supplies connected to a common load. The current share signal is a DC signal that represents the load current that a power supply is providing.

Table 16. ISHARE Signal Characteristics

Signal Type	MIN
V_ISHARE output accuracy	+/-0.5% of full scale plus +/-0.5% reading
V_ISHARE output bandwidth	1 KHz +/-5%
Current share method	Voltage droop plus active average
Current share accuracy	+/-2% individual power supply relative to total average, based on the highest rating of the power supply
Output voltage adjusting range/clamping due to current share loop	+/-200 mV, with +/-5% tolerance
Output voltage adjusting resolution due to current share loop	< 1 mV

IMON - (Pin B24, S13)

The power supply incorporates an output current monitoring pin which will act as a current mirror of the main 12V output, Imon signals from other power supplies in the system can be tied together to provide a mechanism for the system to measure the total output current of all the power supplies combined. The signal includes an output diode to prevent the current from other power supplies' Imon signal from entering a power supply that is not energized. The characteristics of the signal are described in the table.

Table 17. IMON Signal Characteristics

Signal Type	Current Source
Sensitivity (configurable via configuration file)[1]	0 to 2 mA (representing 0 to 200% of rated current) or 10 uA/A[4] with a range of 0 to 200%[5] of rated current.
Minimum bandwidth	40 KHz
Compliance voltage	3.3 V
Time constant	2.9 us to 4 us
Signal delay[2]	<2 us
Input leakage[3]	<500 nA

Note 1 - The IMON signal is able to provide information beyond PL4 levels.
Note 2 - Signal delay is tested using a load step from 0% to 100% and a di/dt of 10 A/us without external capacitance connected to the power supply's main output.
Note 3 - Input leakage is defined when the power supply is not energized, when in standby state or when in cold redundant mode, and it is guaranteed at 85^{0}C and 12 V.
Note 4 - User selectable in the configuration file.
Note 5 - Based on the maximum rated power of the input voltage.

SECTION 5 POWER AND CONTROL SIGNAL DESCRIPTIONS

VINOK - (Pin B25,S14)

VINOK signal indicates that the input voltage is within the range where the power supply can operate normally. Details of the operation are described in Section 2.4 System Timing Requirements.

Table 18. VINOK Signal Characteristics

Signal Type (Active High)	Open collector/drain output from power supply. 1 KΩ Pull-up to 3.3VSB located in the power supply.	
VINOK = High	Input voltage is within the operational range	
VINOK = Low	Input voltage not within the operational range	
	MIN	MAX
Logic level low voltage, Isink = 10 mA	0 V	0.4 V
Logic level high voltage, Isource = 4 mA[1]	3 V	3.46 V
Sink current, VINOK = low		10 mA
Source current, VINOK = high		4 mA
VINOK rise and fall time		100 us

Note 1 - Using 100 KΩ load resistor in the system side.

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

6.1 I^{2}C Bus Signals

CSU2400AT-3-3M0 power supply contains enhanced monitor and control functions implemented via the I^{2}C bus. The CSU2400AT-3-3M0 I^{2}C functionality (PMBus™ and FRU data) can be accessed via the output connector control signals. The communication bus is powered either by the internal 3.3 V 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 I^{2}C bus will not work properly when a unit is inserted into the system without the DC source connected.

Note: PMBus™ functionality can be accessed only when the PSU is powered-up. Guaranteed communication I^{2}C speed is 100 KHz.

A0, A1 (SMBus Address Signals) - (Pins B19, S8)(B20,S9)

The power supply is able to set its SMBus address and FRU address by checking the voltage levels in the A0 and A1 input pins, up to 6 SMBus addresses can be set combining logic states and analog voltage levels in these signals.

SDA, SCL (I^{2}C Data and Clock Signals) - (Pins A19, S1)(A20,S2)

I^{2}C serial data and clock bus - these pins must be pulled-up by a 2.2 Kohm resistor to 3.3 V at the system side.

I^{2}C Bus Communication Interval

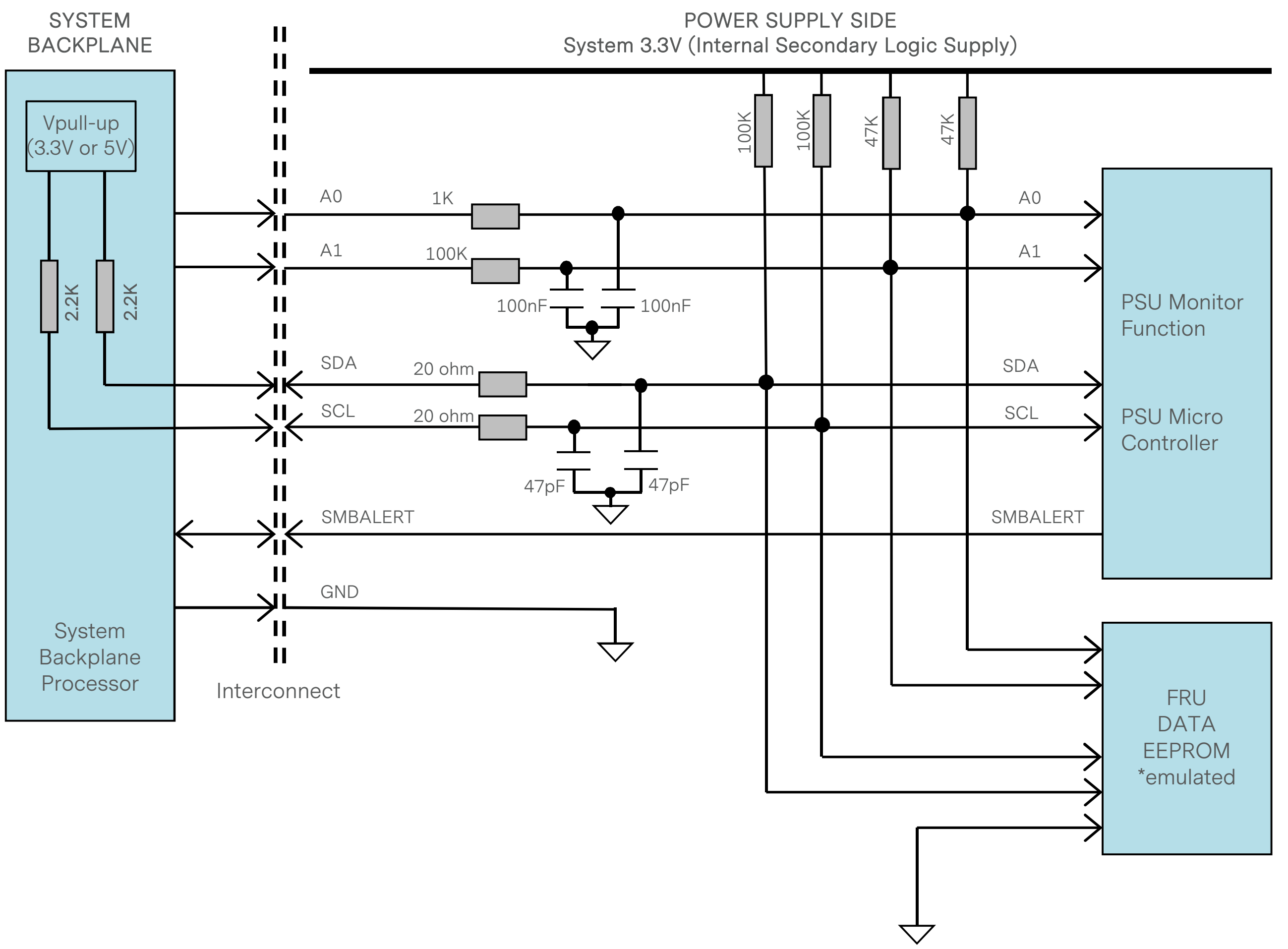
The interval between two consecutive I^{2}C communications to the power supply must be at least 15ms to ensure proper monitoring functionality.

I^{2}C Bus Signal Integrity

The noise on the I^{2}C bus (SDA, SCL lines) due to the power supply will be less than 300 mV peak-to-peak. This noise measurement should be made with an oscilloscope bandwidth limited to 100 MHz. Measurements must be made at the power supply output connector with 2.2 Kohm resistors pulled up to 3.3 V source and a decoupling 47 pF ceramic capacitors to standby output return.

SECTION 6 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}	-	100	-	Kohm
SDA, SCL Internal Bus Capacitance		C_{int}	-	47	-	pF
Recommended External Pull-up Resistor	1 to 4 PSU	R_{ext}	1	2.2	3	Kohm
Recommended External Pull-up Voltage		Vpull-up	3.3	-	5	V

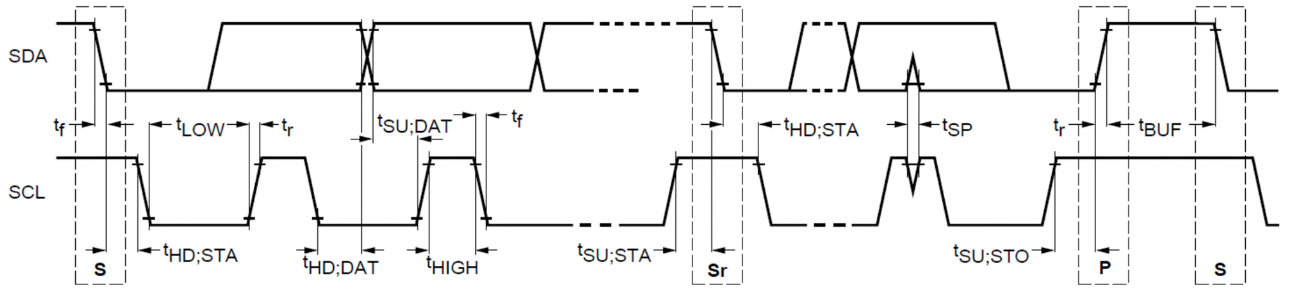
SECTION 6 COMMUNICATION BUS DESCRIPTIONS

6.2 Logic Levels

CSU2400AT-3-3M0 power supply I^2C communication bus will respond to logic levels as per below:

Logic High: 3.3 V nominal (Spec is 2.1 V to 5.5 V)**
Logic Low: 500 mV nominal (Spec is 800 mV max)**

Timings



Parameter	Symbol	Standard-Mode Specs		Actual Measured	Unit
		Min	Max		
SCL clock frequency	f_{SCL}	50	400	51	KHz
Hold time (repeated) START condition	$t_{HD;STA}$	0.6	-	10.04	µS
LOW period of SCL clock	t_{LOW}	1.3	-	15.42	µS
HIGH period of SCL clock	t_{HIGH}	0.6	-	9.72	µS
Setup time for repeated START condition	$t_{SU;STA}$	0.6	-	13.04	µS
Data hold time	$t_{HD;DAT}$	300	-	753.0	nS
Data setup time	$t_{SU;DAT}$	100	-	9586	nS
Rise time	t_r	20	-	385.6	nS
Fall time	t_f	20	-	198.4	ns
Setup time for STOP condition	$t_{SU;STO}$	0.6	-	10.88	µS
Bus free time between a STOP and START condition	t_{BUF}	1.3	-	733	µS

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

6.3 Device Addressing

The CSU2400AT-3-3M0 power supply will respond to supported commands on the SMbus that are addressed according to A1 and A0 pins of output connector.

Address pins are held HIGH by default via pulled up to internal 3.3 V supply. To set the address as “0”, the corresponding address line needs be pulled down to logic ground level. Below tables show the address of the power supply with A0 and A1 pins set to either “0” or “1”.

PSU Slot	Slot ID Bits		PMBus™ Read/ Write Address	FRU device Read / Write Address
	A1	A0		
1	0	0	0xB0 / 0xB1	0xA0 / 0xA1
2	0	1	0xB2 / 0xB3	0xA2 / 0xA3
3	1	0	0xB4 / 0xB5	0xA4 / 0xA5
4	1	1	0xB6 / 0xB7	0xA6 / 0xA7

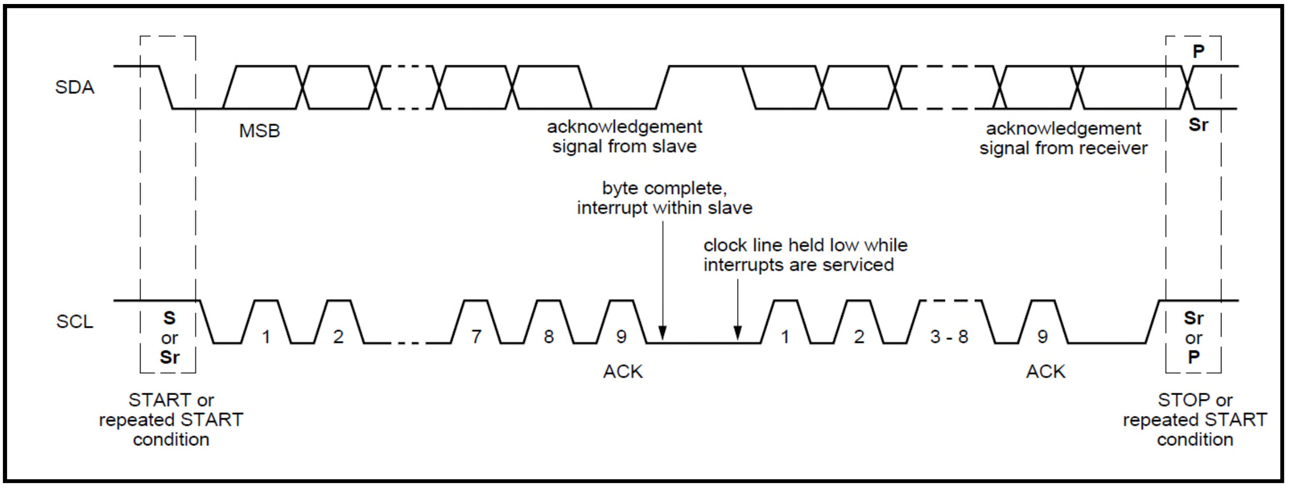
Note 1 – Non-redundant system (single power supply) will use 00 address location.

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

6.4 I²C Clock Synchronization

The CSU2400AT-3-3M0 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 CSU2400AT-3-3M0 is 30 milliseconds.



SECTION 6 COMMUNICATION BUS DESCRIPTIONS

6.5 Cold Redundancy

The CSU2400AT-3-3M0 power supply supports capabilities for cold redundancy. This capability helps improve the efficiency and iTHD of the power subsystem when more than one power supply is used in a system. Cold Redundancy uses the PMBus manufacturer specific command area to define SMBus commands for the system to communicate with the power supplies for enabling, configuration, and monitoring.

When configured as cold redundant, the power supply has a maximum input power of 4 W when configured as cold redundant mode, input power is measured at the lowest nominal input voltage.

Overview

It covers both power supply and system requirements supporting redundant configurations of 1+1, 2+2, and 3+1.

When the power subsystem is in Cold Redundant mode; only the needed power supply to support the best power delivery efficiency are ON. Any additional power supplies, including the redundant power supply, are in Cold Standby state.

Each power supply has an additional signal that is dedicated to supporting cold redundancy; CR_BUS. This signal is a common bus between all power supplies in the system. CR_BUS is asserted (pulled low) when there is a fault in any power supply or the power supply's output voltage falls below the Vfault threshold. Asserting the CR_BUS signal causes all power supplies in the cold standby state to power ON.

Enabling power supplies to maintain best efficiency is achieved by looking at the Load Share bus voltage and comparing it to a programmed voltage level via a PMBus command.

Whenever there is no cold redundant active power supply on the cold redundancy bus driving a HIGH level on the bus all power supplies are ON no matter their defined cold redundant role (active or cold standby). This guarantees that incorrect programming of the cold redundancy states of the power supply will never cause the power subsystem to shutdown or become overloaded. The default state of the power subsystem is all power supplies ON. There needs to be at least one power supply in cold redundant active state or standard redundant state to allow the cold standby state power supplies to go into cold standby state.

The following table shows the state of the power supplies programmed for cold standby mode based on the condition of the CR_BUS signal and the load share bus voltage.

Logic Matrix for Cold Standby Power Supplies:

CR_BUS	Load Share	Cold Standby Power Supply State
High	< VCR_ON	Cold Standby
Low	< VCR_ON	Active
High	> VCR_ON	Active
Low	> VCR_ON	Active

Note: VCR_ON is the voltage threshold set inside the power supplies configured for cold standby which tells them to power down into cold standby state when the load share voltage is less than VCR_ON.

When CR_BUS is asserted (pulled low), all power supplies in the system should go active and immediately provide power to the system.

SMBus Commands for Cold Redundancy

Configuring Cold Redundancy with Cold_Redundancy_Config (D0h)

The PMBus^{TM} manufacturer specific command MFR_SPECIFIC_00 is used to configure the operating state of the power supply related to cold redundancy. This command for Cold_Redundancy_Config is D0h. The table below shows the configuration of the power supply based on the value in the Cold_Redundancy_Config register. PEC is used with the Read-Write Byte SMBus protocol.

The power supplies setup to be the cold standby power supplies can change to standard redundancy mode (D0h = 00h) whenever the CR_BUS is pulled low.

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

Cold Redundancy Configuration Table

Cold_Redundancy_Config (D0h)		
Value	State	Description
00h	Standard Redundancy (Default Power on State)	Turns the power supply into standard redundant load sharing mode. The power supply's CR_BUS# signal can be OPEN but still pull the bus low if a fault occurs to activate any power supplies still in Cold Standby state.
01h	Cold Redundant Active	Defines this power supply to be the one that is always ON in a cold redundancy configuration.
02h	Cold Standby 1	Defines the power supply that is the first to turn on in a cold redundant configuration as the load increases.
03h	Cold Standby 2	Defines the power supply that is the second to turn on in a cold redundant configuration as the load increases.
04h	Cold Standby 3	Defines the power supply that is the third to turn on in a cold redundant configuration as the load increases.
05h	Always Cold Standby	Defines this power supply to be always in cold redundant configuration no matter what the load condition.
06h	Cold Standby 4	Defines the power supply that is fourth to turn on in a cold redundant configuration as the load increases.
07h	Cold Standby 5	Defines the power supply that is fifth to turn on in a cold redundant configuration as the load increases.
08h	Cold Standby 6	Defines the power supply that is sixth to turn on in a cold redundant configuration as the load increases.
09h	Cold Standby 7	Defines the power supply that is seventh to turn on in a cold redundant configuration as the load increases.
0Ah	Cold Standby 8	Defines the power supply that is eighth to turn on in a cold redundant configuration as the load increases.
0Bh	Cold Standby 9	Defines the power supply that is ninth to turn on in a cold redundant configuration as the load increases.
0Ch	Cold Standby 10	Defines the power supply that is tenth to turn on in a cold redundant configuration as the load increases.
0Dh	Cold Standby 11	Defines the power supply that is eleventh to turn on in a cold redundant configuration as the load increases.
0Eh	Cold Standby 12	Defines the power supply that is tweleth to turn on in a cold redundant configuration as the load increases.
0Fh	Cold Standby 13	Defines the power supply that is thirteenth to turn on in a cold redundant configuration as the load increases.
10h	Cold Standby 14	Defines the power supply that is fourteenth to turn on in a cold redundant configuration as the load increases.
11h	Cold Standby 15	Defines the power supply that is fifteenth to turn on in a cold redundant configuration as the load increases.
12h – FFh	Reserved	

Note - When the CR_BUS transitions from a high to a low state, each power supply programmed to be in cold standby state is put into standard redundancy mode (Cold_Redundancy_Config = 00h). For the power supplies to enter cold redundancy mode the system must re-program the power supplies using the Cold_Redundancy_Config command.

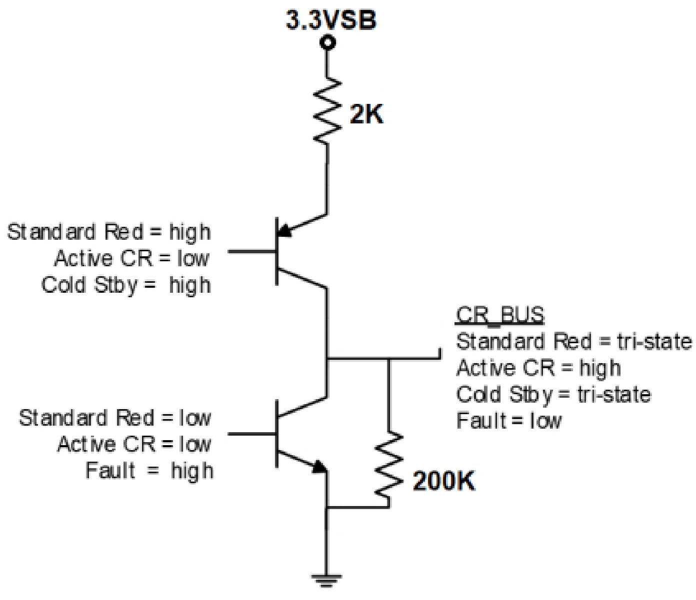
SECTION 6 COMMUNICATION BUS DESCRIPTIONS

Cold Redundant Signal (CR_BUS)

This is a tri-state output signal of the power supply used to communicate a fault or over current has occurred in one of the power supplies. This is used to power on all the power supplies in the system via the CR_BUS. When the signal is pulled high it allows all power supplies in cold standby mode to go into cold standby state when the load is light enough. When the signal I left open on all power supplies it forces them all cold standby power supplies ON.

Cold Redundancy State Table

Cold Redundant Config	Operating State	Power Supply Fault Status	CR_Bus#
Active	On	OK	High
Cold Standby 1,2,3	On	OK	Tri-state
Cold Standby 1,2,3	Cold Standby	OK	Tri-state
Always standby	Cold Standby	OK	Tri-state
Active	Off	Fault	Low
Cold Standby 1,2,3	On	Fault	Low
Cold Standby 1,2,3	Cold Standby	Fault	Low
Always standby	Cold Standby	Fault	Low



SECTION 6 COMMUNICATION BUS DESCRIPTIONS

CR_BUS Signal Characteristic

Signal Type	Value	
	Min	Max
Logic level low (power supply ON)	0V	Vil_cr_bus
Logic level high (power supply OFF)	Vih_cr_bus	-
Source current, Cold_Red = high	Ioh_cr_bus	-
Sink current, Cold_Red = low	-	Iol_cr_bus
Cold_Red fault delay	-	10us
Cold_Red turn on delay	-	100us

BMC Requirements

The BMC uses the COLD_REDUNDANCY_CONFIG command to define/configure the power supply's roll in cold redundancy and to turn on/off cold redundancy.

The BMC schedules a rolling change for which PSU is the Active, Cold Stabdby1, Cold Standby 2, and Cold Standby 3 power supply. The allows for equal loading across power supply over their life.

Events that trigger a re-configuration of the power supplies using the COLD_REDUNDANCY_CONFIG command.

- AC power ON
- PSON power ON
- Power Supply Failure
- Power supply inserted into system

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

6.6 Black Box

The power supply can store PMBus and other data into non-volatile memory upon a critical failure that caused the power supply to shut down. The data can be accessed via the PMBus interface by applying power to the $12V_{SB}$ pins. No AC power needs to be applied to the power supply.

Data is saved to the black box for the following fault events:

- General fault
- Over voltage protection
- Over current protection
- Loss of AC input
- Input voltage fault
- Fan failure
- over temperature protection

Black Box Process:

1) System writes system tracking data to the power supply RAM at power ON.

2) System writes the real time clock data to the PSU RAM once every ~5 minutes.

3) Power supply tracks the number of PSON and AC power cycles in EEPROM.

4) Power supply tracks ON time in EEPROM.

5) Power supply loads warning and fault event counter data from EEPROM into RAM.

6) Upon a warning event, the PSU will increment the associated counter in RAM.

7) Upon and fault event, the PSU will increment the associated counter in RAM.

8) Upon a fault event that causes the PSU to shut down, all event data in the PSU's RAM is saved to event data location N in the power supply's EEPROM. This data includes the real time clock, the number of AC & PSON power cycles, PSU ON time, warning event counters and fault event counters.

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

Commands:

Name: MFR_BLACKBOX
Format: Read Block with PEC (238 bytes)
Code: DCh

	Item	Number of Bytes	Description
System tracking data	System top assembly number	10	The system will write its Intel part number for the system top assembly to the power supply when it is powered ON. This is 9 ASCII characters.
	System serial number	10	The system will write the system serial number to the power supply when it is powered ON. This includes the serial number and date code.
	Motherboard assembly number	10	The system will write the motherboard Intel part number for the assembly to the power supply when it is powered ON. This is 9 ASCII characters.
	Motherboard serial number	10	The system will write the motherboard's serial number to the power supply when it is powered ON. This includes the serial number and date code.
	Present total PSU ON time	3	Total on time of the power supply with PSON asserted in minutes. LSB = 1 minute.
	Present number of AC power cycles	2	Total number of times the power supply powered OFF then back ON due to loss of AC power. This is only counted when the power supply's PSON signal is asserted. This counter will stay at FFFFh once the max is reached.
	Present number of PSON power cycles	2	Total number of times the power supply is powered OFF then back ON due to the PSON signal de-asserting. This is only counted when AC power is present to the power supply. This counter will stay at FFFFh once the max is reached.
Power supply event data (N)		38	Most recent occurrence of saved black box data.
Time stamp			The power supply will track these time and power cycle counters in RAM. When the a black box event occurs the data is saved into the black box.
	Power supply total power on time	3	Total on time of the power supply in minutes. LSB = 1 minute.
	Real time clock data from system (Reserved for future use)	4	This time stamp does not need to generated by the power supply. The system rights a real time clock value periodically to the power supply using the MFR_REAL_TIME command. Format is based on IPMI 2.0. Time is an unsigned 32-bit value representing the local time as the number of seconds from 00:00:00, January 1, 1970. This format is sufficient to maintain time stamping with 1 second resolution past the year 2100. This is based on a long standing UNIX-based standard for time keeping, which represents time as the number of seconds from 00:00:00, January 1, 1970 GMT. Similar time formats are used in ANSI C.
	Number of AC power cycles	2	Number of times the power supply powered OFF then back ON due to loss of AC power at the time of the event. This is only counted when the power supply's PSON signal is asserted.
	Number of PSON power cycles	2	Number of times the power supply is powered OFF then back ON due to the PSON signal deasserting at the time of the event. This is only counted when AC power is present to the power supply.

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

	Item	Number of Bytes	Description
PMBus			The power supply will save these PMBus values into the black box when a black box event occurs. Fast events may be missed due to the filtering effects of the PMBus sensors.
	STATUS_WORD	2	
	STATUS_IOUT	1	
	STATUS_INPUT	1	
	STATUS_TEMPERTATURE	1	
	STATUS_FAN_1_2	1	
	READ_VIN	2	
	READ_IIN	2	
	READ_IOUT	2	
	READ_TEMPERATURE_1	2	
	READ_TEMPERATURE_2	2	
	READ_FAN_SPEED_1	2	
	READ_PIN	2	
	READ_VOUT	2	
Event counters			The power supply will track the total number for each of the following events. These value will be saved to the black box when a black box event occurs. Once a value has reached 15, it will stay at 15 and not reset.
	AC shutdown due to under voltage on input	Lower ½	The power supply will save a count of these critical events to non-volatile memory each time they occur. The counters will increment each time the associated STATUS bit is asserted.
	Thermal shutdown	Upper ½	
	Over current or over power shutdown on output	Lower ½	
	General failure shutdown	Upper ½	
	Fan failure shutdown	Lower ½	
	Shutdown due to over voltage on output	Upper ½	
	Input voltage warning; no shutdown	Lower ½	The power supply will save into RAM a count of these warning events. Events are count only at the initial assertion of the event/bit. If the event persists without clearing the bit the counter will not be incremented. When the power supply shuts down it will save these warning event counters to non-volatile memory. The counters will increment each time the associated STATUS bit is asserted.
	Thermal warning; no shutdown	Upper ½	
	Output current power warning; no shutdown	Lower ½	
	Fan slow warning; no shutdown	Upper ½	
Power supply event data (N-1)		38	
Power supply event data (N-2)		38	
Power supply event data (N-3)		38	
Power supply event data (N-4)		38	

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

Name: MFR_REAL_TIME_BLACK_BOX
Format: Write/Read Block with PEC (4 bytes)
Code: DDh

The system will use this command to periodically write the real time clock data to the power supply.

Format is based on IPMI 2.0. Time is an unsigned 32-bit value representing the local time as the number of seconds from 00:00:00, January 1, 1970. This format is sufficient to maintain time stamping with 1 second resolution past the year 2100.

This is based on a long standing UNIX-based standard for time keeping, which represents time as the number of seconds from 00:00:00, January 1, 1970 GMT. Similar time formats are used in ANSI C.

Name: MFR_SYSTEM_BLACK_BOX
Format: Write/Read Block with PEC (40 bytes). Low byte first.
Code: DEh

The system uses this command to write the following data to the PSU.

Item	Bytes	
System top assembly number	1–10	Low bytes
System serial number	11–20	
Motherboard assembly number	21–30	
Motherboard serial number	31–40	High bytes

Name: MFR_BLACKBOX_CONFIG
Format: Read/Write Byte with PEC
Code: DFh

Bit	Value	Description
0	0 = disable black box function 1 = enable black box function	Writing a ‘1’ enables the power supply with black box function. Writing a ‘0’ disables the power supply black box function. The state of MFR_BLACKBOX_CONFIG will be saved in non-volatile memory so that it is not lost during power cycling. Intel will receive the power supply with the black box function enabled; bit 0 = ‘1’.
1-7		reserved

Name: MFR_CLEAR_BLACKBOX
Format: Send Byte with PEC
Code: E0h

The MFR_CLEAR_BLACKBOX command is used to clear all black box records simultaneously. This command is write only. There is no data byte for this command.

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

6.7 FRU (EEPROM) Data

The FRU (Field Replaceable Unit) data format is compliant with the Intel IPMI v2.0 specification.

The CSU2400AT-3-3M0 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 CSU2400AT-3-3M0 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.

CSU2400AP series FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(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 (Not required, do not reserve)	0	00
2	02	CHASSIS INFO AREA OFFSET (Not required, do not reserve)	0	00
3	03	BOARD INFO AREA OFFSET (Not required, do not reserve)	0	00
4	04	PRODUCT INFO AREA OFFSET	4	04
5	05	MULTI RECORD AREA OFFSET	18	12
6	06	PAD (Not required, do not reserve)	0	00
7	07	ZERO CHECK SUM (256 - (Sum of bytes 0 to 6))	233	E9
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	08 09 0A 0B 0C 0D 0E 0F 10 11 12 13 14 15 16 17 18 19 1A 1B 1C 1D 1E 1F	(08h-1Fh is Reserved, default value is 0.)	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
PRODUCT INFORMATION AREA, 128 BYTES				
32	20	FORMAT VERSION NUMBER (Product Info Area) 7:4 - Reserved, write as 0000b 3:0 - Format Version Number = 1h for this specification	1	01

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

CSU2400AP series FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
33	21	PRODUCT INFO AREA LENGTH(in multiples of 8 bytes)	14	0E
34	22	Language (English)	25	19
35	23	MANUFACTURER NAME TYPE / LENGTH (0CH) 7:6 - (11)b, ASCII code 5:0 - (001100)b, 12 bytes allocation	204	CC
		MANUFACTURER'S NAME 12 bytes sequence		
36	24	“A”= 41h	65	41
37	25	“E”= 45h	69	45
38	26	“I”= 49h	73	49
39	27		32	20
40	28		32	20
41	29		32	20
42	2A		32	20
43	2B		32	20
44	2C		32	20
45	2D		32	20
46	2E		32	20
47	2F		32	20
48	30	PRODUCT NAME Type/Length (24H) 7:6 - (11)b, ASCII code 5:0 - (100100)b, 36 bytes allocation	228	E4
		Product Name, 36 bytes sequence		
49	31	“MCRPS: Common Redundant Power Supply ”	77	4D
50	32	In Decimal = 077d, 067d, 082d, 080d, 083d, 058d, 032d, 067d, 111d,	67	43
51	33	109d, 109d, 111d, 110d, 32d, 82d, 101d, 100d, 117d, 110d, 100d, 97d,	82	52
52	34	110d, 116d, 32d, 80d, 111d, 119d, 101d, 114d, 32d, 83d, 117d, 112d,	80	50
53	35	112d, 108d, 121d	83	53
54	36	In Hex = 4DH, 43H, 52H, 50H, 53H, 3AH, 20H, 43H, 6FH, 6DH, 6DH, 6FH,	58	3A
55	37	6EH, 20H, 52H, 65H, 64H, 75H, 6EH, 64H, 61H, 6EH, 74H, 20H, 50H,	32	20
56	38	6FH, 77H, 65H, 72H, 20H, 53H, 75H, 70H, 70H, 6CH, 79H	67	43
57	39		111	6F
58	3A		109	6D
59	3B		109	6D
60	3C		111	6F
61	3D		110	6E
62	3E		32	20
63	3F		82	52
64	40		101	65
65	41		100	64
66	42		117	75
67	43		110	6E
68	44		100	64
69	45		97	61
70	46		110	6E
71	47		116	74
72	48		32	20
73	49		80	50
74	4A		111	6F
75	4B		119	77
76	4C		101	65
77	4D		114	72
78	4E		32	20
79	4F		83	53
80	50		117	75
81	51		112	70
82	52		112	70
83	53		108	6C
84	54		121	79

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

CSU2400AP series FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
85	55	**PRODUCT PART/MODEL NUMBER** Type/Length (10H) 7:6 - (11)b, ASCII code 5:0 - (010000)b, 16-byte allocation	208	D0
		Part / Model Number		
86	56	“CSU2400AT-3-3M0 ”	67	43
87	57	In Decimal = 067d, 083d, 085d, 050d, 052d, 048d, 048d, 065d, 084d,	83	53
88	58	045d, 051d, 045d, 051d, 077d, 048d, 032d	85	55
89	59	In Hex = 43H, 53H, 55H, 32H, 34H, 30H, 30H, 41H, 54H, 2DH, 33H, 2DH,	51	33
90	5A	33H, 4DH, 30H, 20H	50	32
91	5B		48	30
92	5C		48	30
93	5D		65	41
94	5E		84	54
95	5F		45	2D
96	60		51	33
97	61		45	2D
98	62		51	33
99	63		77	4D
100	64		48	30
101	65		32	20
102	66	**PRODUCT VERSION NUMBER** Type/Length (10h) 7:6 - (11)b, ASCII code 5:0 - (010000)b, 16-byte allocation	208	D0
103	67	**Version,** 16 bytes sequence	48	30
104	68	“0 ”	32	20
105	69		32	20
106	6A		32	20
107	6B		32	20
108	6C		32	20
109	6D		32	20
110	6E		32	20
111	6F		32	20
112	70		32	20
113	71		32	20
114	72		32	20
115	73		32	20
116	74		32	20
117	75		32	20
118	76		32	20
119	77	**PRODUCT SERIAL NUMBER** Type/Length 7:6 - (11)b, ASCII code 5:0 - (010000)b, 14-byte allocation	208	D0
		Serial number, 16 bytes sequence		
120	78	‘’XXXXXXXXXXXXXX‘’	XX	XX
121	79		XX	XX
122	7A		XX	XX
123	7B		XX	XX
124	7C		XX	XX
125	7D		XX	XX
126	7E		XX	XX
127	7F		XX	XX
128	80		XX	XX
129	81		XX	XX
130	82		XX	XX
131	83		XX	XX
132	84		XX	XX
133	85		XX	XX

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

CSU2400AP series FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
134 135	86 87	**Serial number,** 16 bytes sequence	XX XX	XX XX
136 137 138 139 140 141 142	88 89 8A 8B 8C 8D 8E	PAD (reserved)	0 0 193 0 0 0 0	00 00 C1 00 00 00 00
143	8F	ZERO CHECK SUM (256-(sum of bytes 32 to 135)) Per Unit Zero Check Sum: should follow check sum calculation as per IPMI v1.3 specs	NA	NA
MULTI RECORD AREA, 96 BYTES				
144 145 146 147 148	90 91 92 93 94	Power Supply Record Header Record type = 00 for power supply info End of list / Record format version number for 12V output record Record length of 12V output record Record checksum Header checksum	0 2 24 NA NA	00 02 18 NA NA
POWER SUPPLY RECORD				
149 150	95 96	**Combined Wattage,** 2400W = 0960H 2 bytes sequence Byte 1 (LSB) = 60h = 96d Byte 2 (MSB) = 09h = 09d	96 9	60 09
151 152	97 98	**Peak VA,** 2550W = 09F6H 2 bytes sequence Byte 1 (LSB) = F6h Byte 2 (MSB) = 09h	246 9	F6 09
153	99	**Inrush Current,** 35A In Decimal = 35d In Hex = 23H	35	23
154	9A	**Inrush Interval,** 255mS In Decimal = 255d In Hex = FFH	255	FF
155 156	9B 9C	**Low End Input Voltage Range 1(10mV),** (90V/10mV) 9000=2328H 2 bytes sequence Byte 1 (LSB) = 28h Byte 2 (MSB) = 23h	40 35	28 23
157 158	9D 9E	**High End Input Voltage Range 1(10mV),** (240V/10mV) 26400=6720H 2 bytes sequence Byte 1 (LSB) = 20h Byte 2 (MSB) = 67h	32 103	20 67
159 160	9F A0	**Low End Input Voltage Range 2(10mV),** (0V/10mV) 00=0H 2 bytes sequence Byte 1 (LSB) = 0h Byte 2 (MSB) = 0h	0 0	00 00
161 162	A1 A2	**High End Input Voltage Range 2(10mV),** (0V/10mV) 0=0H 2 bytes sequence Byte 1 (LSB) = 0h Byte 2 (MSB) = 0h	0 0	00 00
163	A3	Low End Input Frequency Range	0	00
164	A4	High End Input Frequency Range	60	3C

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

CSU2400AP series FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
165	A5	**AC Dropout Tolerance in ms,** 1ms = 01H	12	0C
166	A6	**Binary Flags: For each of the following binary flags No = 0, Yes = 1.** Bits 7-5: RESERVED, Write as 000b Bit4: Tachometer Pulses Per Rotation / Predictive Fail Polarity BIT = 0 Bit3: Hot Swap / Redundancy Support BIT = 1 Bit2: Auto switch Support BIT = 0 Bit1: Power Factor Correction Support BIT = 1 Bit0: Predictive Fail Support BIT = 1	11	0B
167 168	A7 A8	**Peak Wattage Capacity and Holdup Time, (Set for 2625Watts/15S)** In Decimal = 65 In Hex = 41H (LSB First) In Decimal = 250 In Hex = FAH	65 250	41 FA
169 170 171	A9 AA AB	**Combined Wattage** 0x00 2400W = 0x0960	0 96 9	00 60 09
172	AC	**Predictive Fail Tachometer Lower Threshold,** Not Applicable Predictive failure is not supported	0	00
12V OUTPUT RECORD HEADER				
173 174 175 176 177	AD AE AF B0 B1	Record Type = 01 for power supply info End of List / Record Format Version Number for 12V Output Record Record Length of 12V Output Record Record checksum Header checksum	1 2 13 NA NA	01 02 0D NA NA
12V OUTPUT RECORD				
178	B2	**Output Information,** 000 = 00H Bit 7: Standby information = 0b Bits 6-5: Reserved, write as 000b Bits 4: Current units, 0b = 10mA Bits 3-0: Output number 0 = 000b	0	00
179 180	B3 B4	**Nominal Voltage (10mV), (12.2V / 10mV)** 1220 = 04C4H 2 bytes sequence In Decimal: 196d, 004d In Hex: C4H, 04H	196 4	C4 04
181 182	B5 B6	**Maximum Negative Voltage Deviation (12.11V / 10mV),** 1211 = 04BBH 2 bytes sequence In Decimal: 187d, 004d In Hex: BBH, 04H	187 4	BB 04
183 184	B7 B8	**Maximum Positive Voltage Deviation (12.29V / 10mV),** 1229 = 04CDH 2 bytes sequence In Decimal: 205d, 004d In Hex: CDH, 04H	205 4	CD 04
185 186	B9 BA	**Ripple and Noise pk-pk (mV),** 120 = 78H 2 bytes sequence In Decimal: 120d, 000d In Hex: 78H, 00H	120 0	78 00

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

CSU2400AP series FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
187 188	BB BC	**Minimum Current Draw (mA),** 1000 = 03E8H 2 bytes sequence In Decimal: 232d, 003d In Hex: E8H, 03H	232 3	E8 03
189 190	BD BE	**Maximum Current Draw (mA),** 65535 = FFFFH 2 bytes sequence In Decimal: 255d, 255d In Hex: FFH, FFH	255 255	FF FF
		12VSB OUTPUT RECORD HEADER		
191 192 193 194 195	BF C0 C1 C2 C3	Record type = 01 for DC Output Record End of List / Record Format Version Number for $12V_{SB}$ Output Record Record Length of 12V DC Output Record Record CHECKSUM of $12V_{SB}$ Output Record Header CHECKSUM of $12V_{SB}$ Output Record Header	1 2 13 NA NA	01 02 0D NA NA
		12VSB OUTPUT RECORD		
196	C4	**Output Information,** 129 = 81H Bit 7: Standby Information = 1b Bits 6-4: Reserved, write as 000b Bits 3-0: Output number 1 = 0001b	129	81
197 198	C5 C6	**Nominal Voltage (10mV), (12V / 10mV)** 1200 = 04B0H 2 bytes sequence In Decimal: 176d, 004d In Hex: B0H, 04H	176 4	B0 04
199 200	C7 C8	**Maximum Negative Voltage Deviation (10mV),** 1140 = 0474H 2 bytes sequence In Decimal: 116d, 004d In Hex: 74H, 04H	116 4	74 04
201 202	C9 CA	**Maximum Positive Voltage Deviation (10mV),** 1260 = 04ECH 2 bytes sequence In Decimal: 236d, 004d In Hex: ECH, 04H	236 4	EC 04
203 204	CB CC	**Ripple and Noise pk-pk (mV),** 120 = 78H 2 bytes sequence In Decimal: 120d, 000d In Hex: 78H, 00H	120 0	78 00
205 206	CD CE	**Minimum Current Draw (10mA),** 0000 = 0000H 2 bytes sequence In Decimal: 000d, 000d In Hex: 00H, 00H	0 0	00 00
207 208	CF D0	**Maximum Current Draw (10mA),** 3500 = 0DACH 2 Bytes Sequence In Decimal: 172d, 13d In Hex: ACH, 0DH	172 13	AC 0D
		M-CRPS IDENTIFIER HEADER		
209 210 211 212 213	D1 D2 D3 D4 D5	Record type = C2 End of List / Record Format Version Number Record Length Record CHECKSUM of $12V_{SB}$ Output Record Header CHECKSUM of $12V_{SB}$ Output Record Header	194 139 27 NA NA	C2 8B 1B NA NA
		M-CRPS IDENTIFIER		
214 215 216	D6 D7 D8	Manufacturer ID	0 0 0	00 00 00
217	D9	Record Version	1	01

SECTION 6 COMMUNICATION BUS DESCRIPTIONS

CSU2400AP series FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
218 219	DA DB	M-CRPS Revision [15:8] – Major number = 01h [7:0] – Minor number = 00h In Hex: 00H, 01H(LSB first)	0 1	00 01
220	DC	M-CRPS Version [7:4] – Major number [3:0] – Minor number	16	10
221	DD	M-CRPS Type [7:4] – Input [3:0] – Output	0	00
222	DE	M-CRPS Outline 00h – 73.5 x 185.0 mm 01h – 73.5 x 265.0 mm 02h – 60.0 x 185.0 mm	0	00
223	DF	M-CRPS Cooling Type [7:4] – Cooling [3:0] – Temperature range	0	00
224	E0	M-CRPS Efficiency Titanium	4	04
225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240	E1 E2 E3 E4 E5 E6 E7 E8 E9 EA EB EC ED EE EF F0	OEM	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
241 242 243 244 245 246 247 248 249 250 251 252 253 254 255	F1 F2 F3 F4 F5 F6 F7 F8 F9 F1A FB FC FD FE FF	Reseved	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

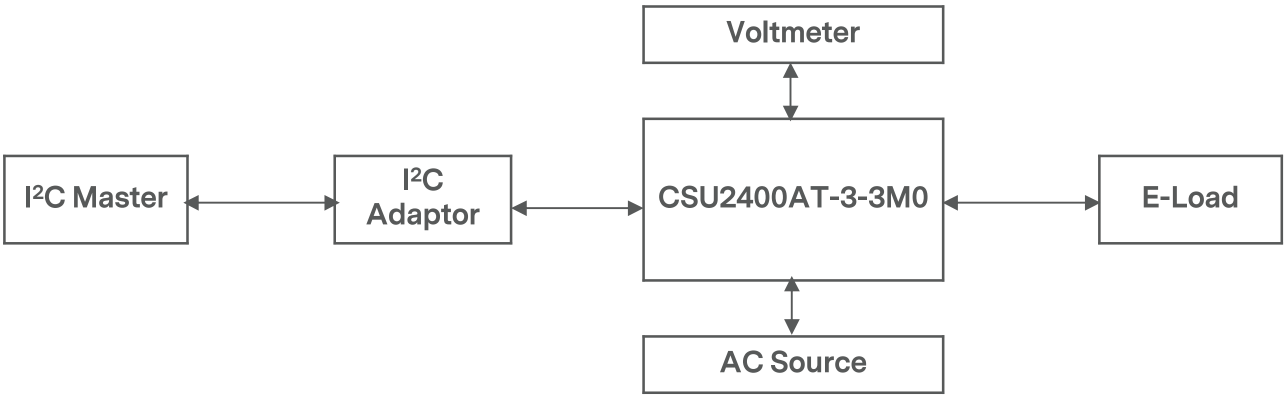
SECTION 7 PMBUS™ SPECIFICATIONS

The CSU2400AT-3-3M0 is compliant with the industry standard PMBus™ protocol for monitoring and control of the power supply via the I^2C interface port.

7.1 CSU2400AT-3-3M0 PMBus™ General Instructions

Equipment Setup

The following is typical I^2C communication setup:



I^2C Accuracy

Output Load	Vout	Pout	Temp	Fan speed
< 2.5%	±2%	-	±2°C	±250 RPM
2.5% ≤ Load < 5%	±2%	±10%	±2°C	±250 RPM
5% ≤ Load < 10%	±2%	±7%	±2°C	±250 RPM
10% ≤ Load < 20%	±2%	±5%	±2°C	±250 RPM
20% ≤ Load < 5%	±1%	±2%	±2°C	±250 RPM
50% ≤ Load < 100%	±1%	±2%	±2°C	±250 RPM

SECTION 7 PMBUS™ SPECIFICATIONS

The CSU2400AT-3-3M0 Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
00h	PAGE	00	R/W	1	Hex	Valid input: 00h, 01h, FFh
01h	OPERATION	0x00	R/W	1	Bitmapped	
02h	ON_OFF_CONFIG	0x15	R/W	1	Bitmapped	
03h	CLEAR_FAULTS	NA	W		N/A	
05h	PAGE_PLUS_WRITE	Variable	BW	Variable	N/A	
06h	PAGE_PLUS_READ	Variable	BWR	Variable	N/A	
10h	WRITE_PROTECT	0x00	R/W	1	Bitmapped	
19h	CAPABILITY	0xB0	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
	b6:5 - Maximum Bus Speed					00 - Maximum supported bus speed, 100 KHz 01 - Maximum supported bus speed, 400 KHz 10 - Maximum supported bus speed, 1 MHz 11 - Reserved
	b4 - SMBALERT#					0 - SMBus Alert Pin not supported 1 - SMBus Alert Pin supported
	b3 - Numeric Format					0 - Linear11, Ulinear16, Slinear16, or Direct 1 - IEEE half precision floating point format
	b2 - AVSBus					0 - AVSBus not supported 1 - AVSBus supported
	b1:0					Reserved
1Ah	QUERY	Variable	BWR	2	Bitmapped	Supported in ISP mode
1Bh	SMBALERT_MASK	Variable	WW/BWR	2	Bitmapped	Default masks per Intel spec: Page 00: STATUS_VOUT = FFh STATUS_IOUT = FFh STATUS_INPUT = FFh STATUS_TEMP = FFh STATUS_CML = FFh Page 01: STATUS_VOUT = FFh STATUS_IOUT = DFh STATUS_INPUT = EFh STATUS_TEMP = BFh STATUS_CML = FFh Non-paged: STATUS_FANS_1_2 = FFh

SECTION 7 PMBUS™ SPECIFICATIONS

The CSU2400AT-3-3M0 Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
30h	COEFFICIENTS	0x05 0x01 0x00 0x00 0x00 0x00	BWR	6	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
33h	FREQUENCY_SWITCH	0x00	R	1	Hex	
35h	VIN_ON	0xF2C8	R	2	Linear	
36h	VIN_OFF	0xF2AC	R	2	Linear	
3Ah	FAN_CONFIG_1_2	0x80	R/W	1	Bitmapped	
	b7	1				0 - No fan is installed in position 1 1 - Fan is installed in position 1
	b6	0				0 - Fan is commanded in DC. 1 - Fan is commanded in RPM.
	b5:4	00				00 - 1 pulse per revolution 01 - 2 pulse per revolution 10 - 3 pulse per revolution 11 - 4 pulse per revolution
3Bh	FAN_COMMAND_1	0x0000	R/W	2	Linear	Adjusts the operation of the Fans in RPM/DC. The device may override the command, if it requires higher value to maintain proper device temperature
40h	VOUT_OV_FAULT_LIMIT	0x1BE6	R	2	Linear	
41h	VOUT_OV_FAULT_RESPONSE	0x80	R	1	Bitmapped	
42h	VOUT_OV_WARN_LIMIT	0x1B00	R	2	Linear	
43h	VOUT_UV_WARN_LIMIT	0x1380	R	2	Linear	
44h	VOUT_UV_FAULT_LIMIT	0x1380	R	2	Linear	
45h	VOUT_UV_FAULT_RESPONSE	0x80	R	1	Bitmapped	
46h	IOUT_OC_FAULT_LIMIT	0xF390	R	2	Linear	
47h	IOUT_OC_FAULT_RESPONSE	0x80	R	1	Bitmapped	
4Ah	IOUT_OC_WARNING_LIMIT	0xF3FF	R/W	2	Linear	
4Fh	OT_FAULT_LIMIT	0xEBE8	R	2	Linear	
50h	OT_FAULT_RESPONSE	0x80	R	1	Bitmapped	
51h	OT_WARN_LIMIT (Hot Spot)	0xEBC0	R/W	2	Linear	Secondary ambient temperature warning threshold, in degree C operating limit
55h	VIN_OV_FAULT_LIMIT	0xFA44	R	2	Linear	

SECTION 7 PMBUS™ SPECIFICATIONS

The CSU2400AT-3-3M0 Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
56h	VIN_OV_FAULT_RESPONSE	0x80	R	1	Bitmapped	
57h	VIN_OV_WARN_LIMIT	0xFA3A	R	2	Linear	
58h	VIN_UV_WARN_LIMIT	0xF2BC	R	2	Linear	
59h	VIN_UV_FAULT_LIMIT	0xF2AC	R	2	Linear	
5Ah	VIN_UV_FAULT_RESPONSE	0x80	R	1	Bitmapped	
5Dh	IIN_OC_WARN_LIMIT	08 AC D3 AC D3 AC D3 AC C3	R	9	N/A	
6Bh	PIN_OP_WARN_LIMIT	0x128F	R	2	Linear	
78h	STATUS_BYTE	0x00	R	1	Bitmapped	Returns the summary of critical faults
	b7 - BUSY					Not supported
	b6 - OFF					Unit is off
	b5 - VOUT_OV_Fault					Output over-voltage fault has occurred
	b4 - IOUT_OC_Fault					Output over-current fault has occurred
	b3 - VIN_UV_Fault					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					Not supported
79h	STATUS_WORD	0x0000	R	2	Bitmapped	Summary of 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_SPECIFIC					
	b11 - POWER_GOOD#					The POWER_GOOD (PWOK) signal is de-asserted
	b10 - FANS					A fan or airflow fault or warning has occurred
	b6 - OFF					Unit is off
	B5 - VOUT_OC_FAULT					Output over-voltage fault has occurred
	b4 - IOUT_OC_FAULT					Output over-current fault has occurred
	b3 - VIN_UV_FAULT					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

SECTION 7 PMBUS™ SPECIFICATIONS

The CSU2400AT-3-3M0 Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
7Ah	STATUS_VOUT	0x00	R/W	1	Bitmapped	
	b7 - VOUT OV_Fault					VOUT over-voltage fault
	b6 - VOUT_OV_WARNING					
	b5 - VOUT_UV_WARNING					
	b4 - VOUT UV_ Fault					VOUT under-voltage fault
7Bh	STATUS_IOUT	0x00	R/W	1	Bitmapped	
	b7 - IOUT Overcurrent Fault					IOUT overcurrent fault
	b5 - IOUT Overcurrent Warning					IOUT overcurrent warning
	b1 - POUT_OP_FAULT					POUT overpower fault
	b0 - POUT_OP_WARNING					POUT overpower warning
7Ch	STATUS_INPUT	0x00	R/W	1	Bitmapped	Input related faults and warnings
	b7 - VIN_OV_FAULT					Not supported
	b6 - VIN_OV_WARNING					VIN over-voltage warning
	b5 - VIN_UV_WARNING					VIN under-voltage warning
	b4 - VIN_UV_FAULT					VIN under-voltage fault
	b3 - Unit Off for Low Input Voltage					Unit is off for insufficient input voltage.
	b1 - IIN_OC_WARNING					IIN overcurrent warning
	b0 - PIN_OP_WARNING					PIN overpower warning
7Dh	STATUS_TEMPERATURE	0x00	R/W	1	Bitmapped	Temperature related faults and warnings
	b7 - Over Temperature Fault					Over temperature fault
	b6 - Over Temperature Warning					Over temperature warning
7Eh	STATUS_CML	0x00	R	1	Bitmapped	
	b7 - Invalid/Unsupported command					
	b6 - Invalid/Unsupported Data					
	b5 - Packet Error Check Failed					
	b4 - Memory Fault Detected					
	b3 - Processor Fault Detected					
	b2 - Reserved					
	b1 - A communication fault other than the ones listed in this table has occurred					
	b0 - Other Memory Or Logic Fault has occurred					
7Fh	STATUS_OTHER	0x00	R	1	Bitmapped	
80h	STATUS_MFR_SPECIFIC	0x00	R	1	Bitmapped	
	b4 - Power supply line status change					Asserted when the power supply detects a line status condition change
	b2 - High Line input, power derated					Asserted when the power supply's input voltage falls below the voltage required to achieve the higher power level.

SECTION 7 PMBUS™ SPECIFICATIONS

The CSU2400AT-3-3M0 Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
81h	STATUS_FANS_1_2	0x00	R	1	Bitmapped	
	b7 - Fan1 Fault					Fan1 Fault
	b6 - Fan2 fault					Fan2 Fault
	b5 - Fan1 Warning					Fan1 Warning
	b4 - Fan2 Warning					Fan2 Warning
86h	READ_EIN	Variable	BR	7	Direct	Returns the accumulated input power over time.
87h	READ_EOUT	Variable	BR	7	Direct	Returns the accumulated output power over time.
88h	READ_VIN	Variable	R	2	Linear	Returns input voltage in Volts AC
89h	READ_IIN	Variable	R	2	Linear	Returns input current in Amperes
8Ah	READ_VCAP	Variable	R	2	Linear	Returns input current in capacitance
8Bh	READ_VOUT	Variable	R	2	Linear16	Returns the actual, measured voltage in Volts.
8Ch	READ_IOUT	Variable	R	2	Linear	Returns the output current in amperes.
8Dh	READ_TEMPERATURE_1	Variable	R	2	Linear	Returns the ambient temperature in degree C
8Eh	READ_TEMPERATURE_2	Variable	R	2	Linear	Returns the hot pot temperature in degree C
8Fh	READ_TEMPERATURE_3	Variable	R	2	Linear	Returns the exhaust temperature in degree C
90h	READ_FAN_SPEED_1	Variable	R	2	Linear	Speed of fan 1
91h	READ_FAN_SPEED_2	NA	R	2	Linear	Speed of fan 2 (not support)
94h	READ_DUTTY_CYCLE	0x32	R	1		
96h	READ_POUT	Variable	R	2	Linear	Returns the output power, in Watts
97h	READ_PIN	Variable	R	2	Linear	Returns the input power, in Watts
98h	PMBUS_REVISION	0x22	R	1	Bitmapped	Reads the PMBus revision number
	b7:5					Part 1 Revision 0000 - Revision 1.0 0001 - Revision 1.1 0010 - Revision 1.2
	b4:0					Part 2 Revision 0000 - Revision 1.0 0001 - Revision 1.1 0010 - Revision 1.2
99h	MFR_ID	Variable	BR	13	ASCII	
9Ah	MFR_MODEL	Variable	BR	17	ASCII	Supported in ISP mode Model number matching label
9Bh	MFR_REVISION	Variable	BR	17	ASCII	
9Ch	MFR_LOCATION	Variable	BR	17	ASCII	
9Dh	MFR_DATE	YY/MM/DD	BR	7	N/A	
9Eh	MFR_SERIAL	Variable	BR	15	ASCII	
9Fh	APP_PROFILE_SUPPORT	0x05	R	1	ASCII	
A0h	MFR_VIN_MIN	0x005A	R	2	Linear	
A1h	MFR_VIN_MAX	0x0108	R	2	Linear	
A2h	MFR_IIN_MAX	0xD3AD	R	2	Linear	

SECTION 7 PMBUS^{TM} SPECIFICATIONS

The CSU2400AT-3-3M0 Supported PMBus^{TM} Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
A3h	MFR_PIN_MAX	0x128F	R	2	Linear	Maximum input Power
A4h	MFR_VOUT_MIN	0x1614	R	2	Linear	Minimum output voltage
A5h	MFR_VOUT_MAX	0x19EC	R	2	Linear	Maximum output voltage
A6h	MFR_IOUT_MAX	0xF313	R	2	Linear	Maximum output current
A7h	MFR_POUT_MAX	0x1258	R	2	Linear	Maximum output power
A8h	MFR_TAMBIENT_MAX	0x0037	R	2	Linear	
A9h	MFR_TAMBIENT_MIN	0x07FB	R	2	Linear	
ADh	IC_DEVICE_ID	04 39 30 00 00	BR	5	N/A	
AEh	IC_DEVICE_REV	04 14 00 00 00	BR	5	N/A	
B0h	Reserve		BWR			
B1h	Reserve		BWR			
B2h	Reserve		BWR			
B3h	MFR_EFFICIENCY_DATA	2400W: input type, 4W, 85%, 90%, 94%, 95%, 95.5%, 96%, 95%, 94%, 93%, 92%, 91%	BR	46	N/A	
B4h	Reserve		BWR			
B8h	Reserve		BWR			
C0h	MFR_MAX_TEMP_1	0xE3C0	R	2	Linear	
C1h	MFR_MAX_TEMP_2	0xEBC0	R	2	Linear	
C2h	MFR_MAX_TEMP_3	0xEBC0	R	2	Linear	
D0h	MFR_COLD_REDUNDANCY_CONFIG	0x00	R/W	1	Hex	
D1h	MFR_READ_CONFIG_FILE_SIZE	03 00 28 00	BR	4	N/A	
D2h	MFR_READ_CONFIG_BLOCK_SIZE	0x0010	R	2	Hex	
D3h	MFR_READ_CONFIG_FILE	Variable	BWR	17	N/A	
D4h	MFR_HW_COMPATIBILITY	0x0002	R	2	Bitmapped	
D5h	MFR_FWUPLOAD_CAPABILITY	0x04	R	1	Bitmapped	
D6h	MFR_FWUPLOAD_MODE	0x00	R/W	1	Bitmapped	
D7h	MFR_FWUPLOAD	Variable	BW	Variable	N/A	
D8h	MFR_FWUPLOAD_STATUS	0x00	R	2	Bitmapped	
D9h	MFR_FW_REVISION	Variable	BR	8	Hex	
DAh	MFR_SPDM	Variable	BWR	Variable	N/A	
DBh	MFR_FRU_PROTECTION	0x01	R/W	1	Bitmapped	
DCh	MFR_BLACKBOX	Variable	BR	238	N/A	
DDh	MFR_REAL_TIME_BLACK_BOX	Variable	BWR	5	N/A	
DEh	MFR_SYSTEM_BLACK_BOX	Variable	BWR	41	N/A	
DFh	MFR_BLACKBOX_CONFIG	0x01	R/W	1	Bitmapped	
E0h	MFR_CLEAR_BLACKBOX	NA	W	1		
E1h	MFR_LINE_STATUS	Variable	R/W	1	Bitmapped	
E2h	MFR_SYSTEM_LED_CNTL	0x0007	R/W	2	Bitmapped	

SECTION 7 PMBUS™ SPECIFICATIONS

The CSU2400AT-3-3M0 Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
E9h	MFR_PEAK_CURRENT_RECORD	Variable	BWR	5	N/A	
EBh	MFR_COMPONENT_ID	04 7E BD 01 00	BR	5	N/A	
ECh	MFR_TOT_POUT_MAX	0x1258	R	2	Linear	
EDh	MFR_VOUT_MARGINING	0x0000	R/W	2	Bitmapped	
EEh	MFR_OCWPL1_SETTING	05 0C FF 03 E8 F3	BWR	6	N/A	
F0h	MFR_PWOK_WARNING_TIME	0xBACC	R/W	2	Linear	Power OK warning time
F1h	MFR_MAX_IOUT_CAPABILITY	0E 13 F3 89 F3 20 4E 62 FA 0A 00 89 FA 14 00	BR	15	N/A	
F2h	MFR_FPC_MAIN_MIN_OFF_TIME	0x0001	R/W	2	Linear	Main output's minimum OFF time
F3h	MFR_FPC_12VSB_MIN_OFF_TIME	0x0001	R/W	2	Linear	Standby output's minimum OFF time
FEh	MFR_SPECIFIC_COMMAND EXT	N/A	N/A	N/A	N/A	Customer specific command set extension

SECTION 7 PMBUS™ SPECIFICATIONS

Data Format: Linear11

Linear11 is linear data format used for the non output voltage related PMBus commands, for example output current, input voltage, input current, temperature, etc.

Linear data format follows the equation: $X = Y \times 2^N$

Where: X = real world data in decimal

Y = 11-bit transmitted value / mantissa

N = 5-bit exponent

Convert Linear Data Format to Real World Data

The following steps show how to convert from linear data format to its corresponding real world data.

1. Convert data from hex format to binary format.

   Ex. The reading of 88h command (READ_VIN) is F398 hex, in Binary = 1111001110011000.

2. Separate the exponent N from the mantissa Y.

   The format is aaaaaBBBBBBBBBBB

   Where: a is binary format of exponent N = aaaaa = 11110

   B is binary format of mantissa Y = BBBBBBBBBBB = 01110011000

3. Convert exponent N from binary format to its corresponding decimal format.

   N = 11110, convert to two's complement, it is -2 in decimal.

   N = -2

4. Convert mantissa Y from binary format to its corresponding decimal format.

   Y = 01110011000, convert to decimal, Y = 920.

5. Solve for the real world data X using below equation.

   $X = Y \times 2^N$

   $= 920 \times 2^{-2}$

   = 230VAC

SECTION 7 PMBUS^{TM} SPECIFICATIONS

Data Format: Linear16

Linear16 is linear data format used for the output voltage related PMBus commands.

Linear data format follows the equation: Voltage = V x 2^N

Where: Voltage = real world data in decimal

V = 16-bit transmitted value / mantissa

N = exponent depends on the VOUT_MODE command 20h

Convert Linear Data Format to Real World Data

The following steps show how to convert from linear data format to its corresponding real world data.

1. Find the VOUT_MODE command value of CSU2400AT-3-3M0, that is 17h.

Mode	Bits [7:5] (mode)	Bits [4:0] (Parameter)
Linear	000b	Five bit two's complement exponent for the mantissa delivered as the data bytes for an output voltage related command.

2. Calculate N according to above table. 17h is 00010111 in binary.

   Convert bits [4:0] 10111 to two's complement, it is -9 in decimal.

   N = -9

3. Ex. The reading of 8Bh READ_VOUT command is 1866 hex. Convert to decimal directly. It is 6246 decimal.

   V = 6246

4. Solve for the real world data X using below equation.

   X = V x 2^N

   = 6246 x 2^{-9}

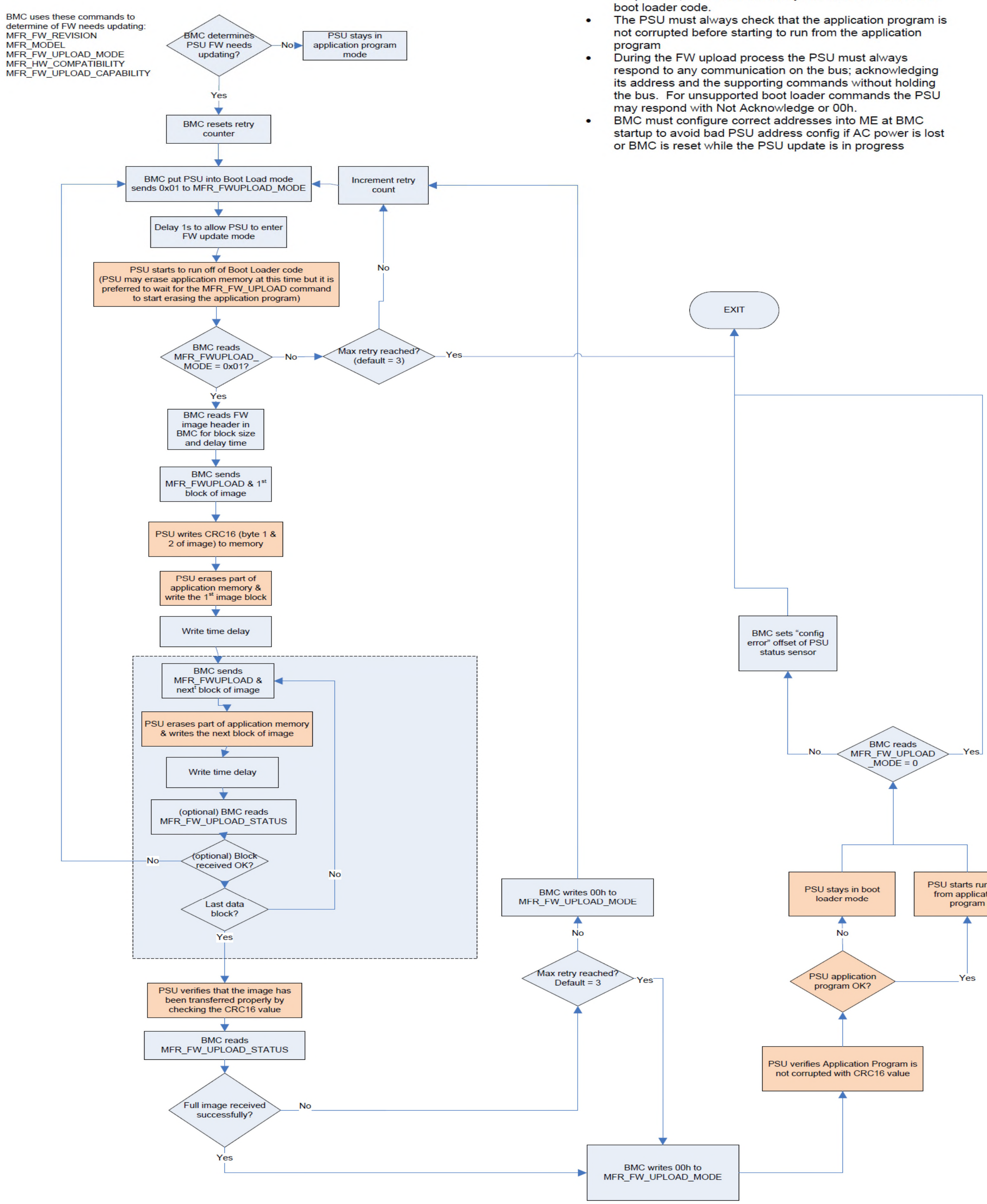
   = 12.2 V

SECTION 7 PMBUS™ SPECIFICATIONS

7.2 Firmware Update Process

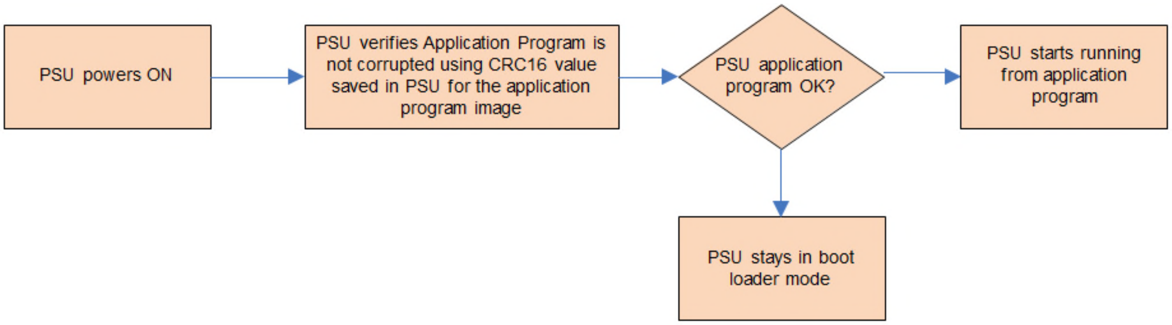
IMPORTANT!

- PSU may be in standby mode or ON mode during FW update process
- If the FW update process is interrupted at any point during the process; the PSU must always be able to return to the boot loader code.
- The PSU must always check that the application program is not corrupted before starting to run from the application program
- During the FW upload process the PSU must always respond to any communication on the bus; acknowledging its address and the supporting commands without holding the bus. For unsupported boot loader commands the PSU may respond with Not Acknowledge or 00h.
- BMC must configure correct addresses into ME at BMC startup to avoid bad PSU address config if AC power is lost or BMC is reset while the PSU update is in progress



SECTION 7 PMBUS™ SPECIFICATIONS

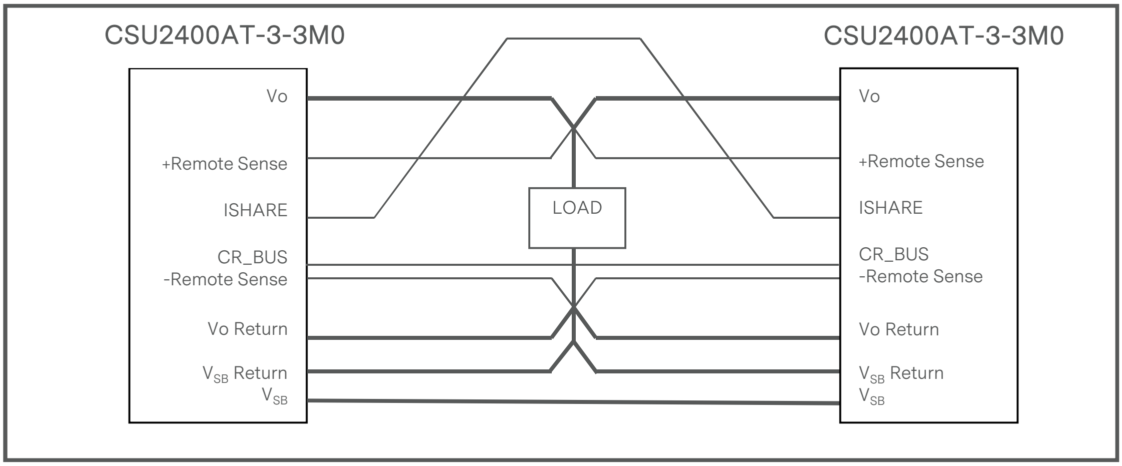
7.3 PSU Boot Flow During Powering ON



SECTION 8 APPLICATION NOTES

8.1 Current Sharing

The CSU2400AT-3-3M0 main output V_O is equipped with current sharing capability. At 1+1 redundant power supply system, the +12V output with droop and active current sharing will share load current within a 5% tolerance at each PSU works within 10% to 20% of its rated load; 5% tolerance at ≥ 20% of rated load. Redundant backup one of the power failures cannot affect other power supply operations and outputs. If ISHARE pin is short-circuited to the ground evenly, the power supply output should meet the specification.



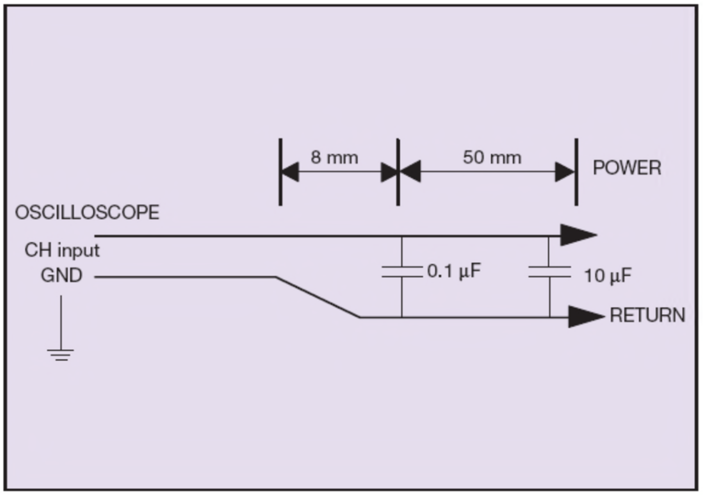
The power supplies must be able to share current with any combination of 1 to 6 PSUs in the system. Maximum output power for systems with "n" PSU of "W" power each, in parallel: 1*W +0.95*(n-1)*W.

PSU SKUs	Number of Supplies	Maximum System Power Rating
1+0	1	100% of One PSU Rating
1+1	2	100% of One PSU Rating
2+0	2	100%+(95% x 1) x PSU Rating
2+1	3	100%+(95% x 1) x PSU Rating
2+2	4	100%+(95% x 1) x PSU Rating
3+0	3	100%+(95% x 2) x PSU Rating
3+1	4	100%+(95% x 2) x PSU Rating
3+2	5	100%+(95% x 2) x PSU Rating
3+3	6	100%+(95% x 2) x PSU Rating

SECTION 8 APPLICATION NOTES

8.2 Output Ripple and Noise Measurement

The setup outlined in the diagram below has been used for output voltage ripple and noise measurements on the CSU2400AT-3-3M0. When measuring output ripple and noise, a scope jack in parallel with a 0.1 uF ceramic chip capacitor, and a 10 uF tantalum capacitor will be used. Oscilloscope can be set to 10 Hz to 20 MHz bandwidth for this measurement.



SECTION 9 RECORD OF REVISION AND CHANGES

Issue	Date	Description	Originators
1.0	01.26.2026	First issue	Kelly Ma

Note – If you have any feedback for this document, feel free to contact kathy.wang@aei.com.

ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than four decades to perfecting power for its global customers. AE designs and manufactures highly engineered, precision power conversion, measurement and control solutions for mission-critical applications and processes.

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For international contact information,
visit advancedenergy.com.

powersales@aei.com (Sales Support)
productsupport.ep@aei.com (Technical Support)
+1 888 412 7832