

PS-15C-2 Power Supply Float Charger

13.8 VDC at 0 to 25 ADC

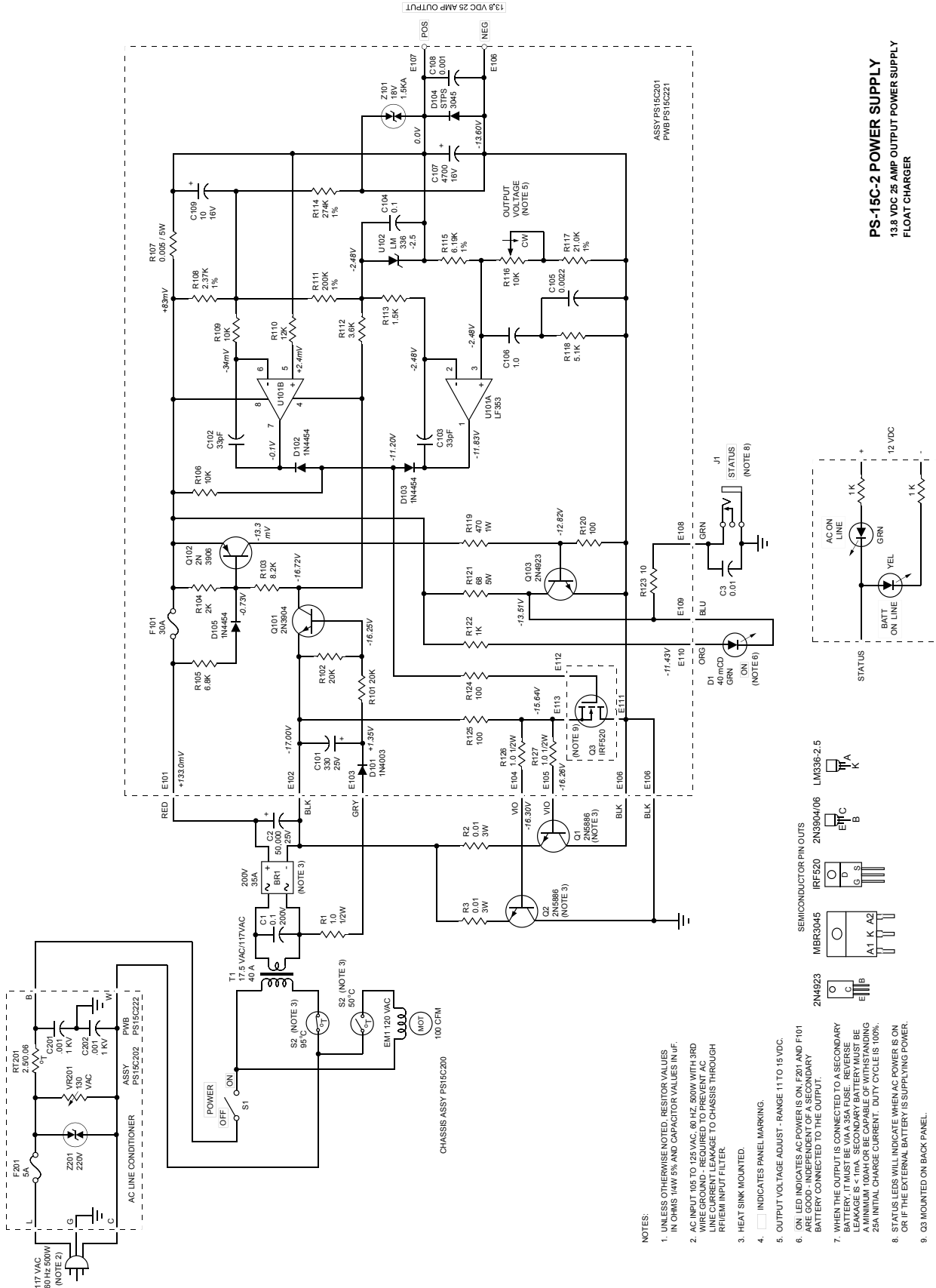


Designed to be used with MC-20A DC Buss Monitor and Control for a complete station power system.

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PS-15C-2 Power Supply Float Charger



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Applications

- Designed specifically for continuous, unattended charging of a secondary battery or as a stand-alone continuous duty, high reliability power supply.
- Excellent for powering remote systems and intended to operate in or near RF fields such as those in the proximity of an Amateur Radio transmitting antenna.
- Intended as the AC power supply of a DC power system using the MC-20A Power Monitor which will provide a complete system for under voltage disconnect, over voltage shut-down, and DC buss monitoring.



Features

- excellent voltage regulation
- excellent load step response
- very low ripple and noise DC output
- adjustable output voltage
- dual mode current limit
- very low reverse leakage current (drawn from the battery during AC off conditions)
- load sharing that does NOT require series diodes
Caution: When connected to another power source or battery it must through a 40 A fuse to prevent serious damage if a fault condition occurs.
- fused in both AC and DC sections
- output reverse voltage protection
- RFI/EMI immune output
- RFI/EMI input filter on AC line with surge and in-rush current protection
- special "POWER ON" LED that functions as a performance monitor indicating that AC power is present, power switch is on, the AC fuse is good and the DC fuse is good and is able to do so even in the presences of an externally connected power source
- status output that allows two LEDs to indicate that AC power is providing the DC output or that the secondary battery is providing the DC output.
- thermostatically controlled 100 CFM fan that minimizes the heat sink size and internal temperature rise, including over-temperature shut down
- 100% duty cycle output at ambient temperatures up to +40 °C
- simple rugged circuit with no high voltage switching or noise generation that requires complex filtering and shielding

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Characteristics

Parameter	Conditions	Value	Notes
Input Voltage	60 Hz Line Output Load 0 to 25 ADC	105 to 125 VAC	1,2
Input Current	120.0 VAC Input 13.60 VDC Output 20.0 ADC Output Load	3.10 Amp AC	
Output Voltage Range	117.0 VAC Input 0 to 25 ADC Output Load	11.0 to 15.0 VDC	
Line Regulation	13.60 VDC @ 0 ADC Output 110.0 VAC to 127.6 VAC	$\Delta V_o = 2.3 \text{ mV (0.017\%)}$	
	13.60 VDC @ 15.0 ADC Output 115.0 VAC to 125.0 VAC	$\Delta V_o = 1.0 \text{ mV (0.007\%)}$	
Load Regulation	$V_o = 13.60 \text{ VDC}$ $V_i = 120.0 \text{ VAC}$ $\Delta I_o = 0 \text{ to } 15.0 \text{ ADC}$	$\Delta V_o = 7.0 \text{ mV (0.051\%)}$	
	$V_o = 13.60 \text{ VDC}$ $V_i = 120.0 \text{ VAC}$ $\Delta I_o = 0 \text{ to } 20.0 \text{ ADC}$	$\Delta V_o = 8.8 \text{ mV (0.065\%)}$	
Ripple and Noise	$V_o = 13.60 \text{ VDC}$ $V_i = 120.0 \text{ VAC}$ $I_o = 15.0 \text{ ADC}$	$< 200 \mu\text{Vpp}$	3
Load Step Response	$V_o = 13.60 \text{ VDC}$ $V_i = 120.0 \text{ VAC}$ $\Delta I_o = 0 \text{ to } 20 \text{ Amp to } 0$	+/- 200 mVpk recovering within 10% in 20 μs	
	$V_o = 13.60 \text{ VDC}$ $V_i = 120.0 \text{ VAC}$ $\Delta I_o = 0 \text{ to } 4.0 \text{ Amp to } 0$	+ 200 mV recovers in 5 μs - 250 mV recovers in 7 μs	4 See Fig.s 1,2,3
Output Current Limit	$V_o = 13.80 \text{ VDC}$ $V_i = 120.0 \text{ VAC}$	$V_o = 13.68 \text{ VDC}$ @ 25.4 ADC as fold back starts	See Fig. 4
Reverse Leakage Current	$V_i = 0 \text{ VAC}$ $V_o = 12.7 \text{ VDC (from external source)}$	Less than 1 mA (Typically 450 μA)	
Operating Temperature Range	$V_i = 120.0 \text{ VAC}$ $V_o = 13.80 \text{ VDC}$ $I_o = 0 \text{ to } 25 \text{ ADC}$	-20 °C to + 40 °C	

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Characteristics (Continued)

- Cooling provided by thermostatically controlled 100 CFM fan - unrestricted air flow required
- Over temperature shut down provided by second thermostatic switch
- Load sharing requires NO series diodes and is possible with another power supply or a secondary battery
- Reverse voltage protection provided by 30 Amp Schottky rectifier diodes shunted across the output
- Voltage transient protection provided by a 1500 VA, 18 V Silicon Avalanche diode across the output
- Status output allows two LEDs to indicate if the power supply is providing output current or if an externally connected secondary battery is (without any series diodes)
- Input AC line has EMI/RFI filtering, 220 V @ 1500 VA Silicon back to back Avalanche protection and in-rush current limiting - note third wire ground is necessary to avoid AC line leakage current to the chassis
- Output duty cycle is 100% over the entire input / output voltage, output current and temperature ranges

Caution: Connection of the PS-15C-2 output to another power source or battery must be through a 40 A fuse to prevent serious damage if a fault condition occurs.

Failure to heed this caution can result in equipment damage and or FIRE.

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Characteristics (Continued)

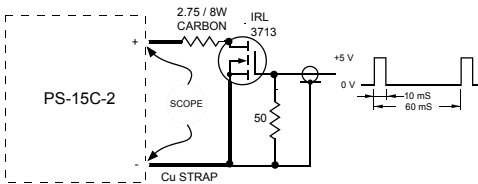


Figure 1. Load step test circuit.

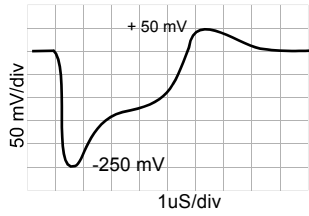


Figure 2. Output voltage response for 0 to 4 Amp load step.

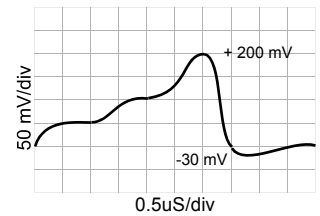


Figure 3. Output voltage response for 4 Amp to 0 load step.

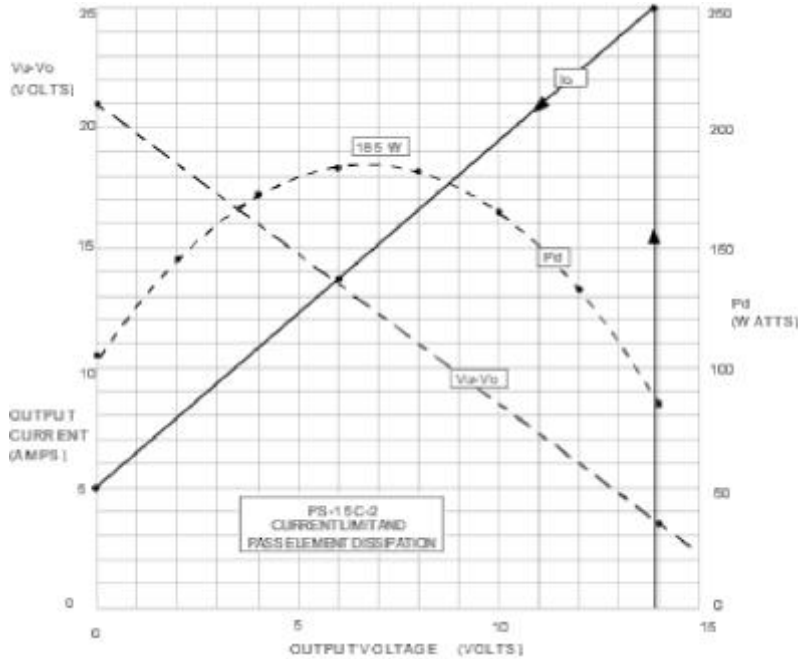


Figure 4. Output current limit and fold back.

Notes:

1. AC power has filter capacitors from both leads to chassis ground which is connected to third wire ground. If not connected to a ground source, leakage current will cause the chassis to be at 60 VAC.
2. Depending on AC line loss, output current may be somewhat less than 25A for line voltages below 110 VAC.
3. Instrument limited on my prototype measurements.
4. Measured using 500 W wire wound resistor which exhibited considerable inductance.

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Supplier is Mouser unless otherwise noted. Mous = Mouser, Digi = Digi-Key

Material List PS15C200 Chassis Assembly

Qty	Designator	Value/Type	Description	Part Number	Supplier
1	BR1	200V, 35 Amp	Bridge rectifier	583-MP352	
1	C1	0.1uF, 200V	Polyester Film	140-PF2D104K	
1	C2	50,000uF, 25V	Aluminum	75-DX503G025CC2A	
1	C3	0.01uF, 50V	Ceramic disk Z5U	140-50Z2-103M-RC	
1	D1	40 mCD	T-1 3/4 GRN LED	604-WP7113SGD	
1	EM1	117 VAC, 100 CFM	4.75" Muffin fan	670-OA109AP111TB	
1	J1	3.5mm Open Ckt	Chassis mtg jack	16PJ135	
2	Q1, Q2	2N5886	25A, 200W NPN	511-2N5886	
1	Q3	IRF520	N-CH PWR FET	844-IRF520	
1	R1	1.0 Ω , 0.5W, 5%	Carbon Film	293-1.0-RC	
2	R2, R3	0.01 Ω , 3W, 5%	Metal element	66-LOB3R010JLF	
1	S1	125VAC, 10A SPST	Rocker switch	540-CRE22F2FBBNE	
1	S2	50 °C NO	Thermal switch		
1	S3	95 °C NC	Thermal switch		
1	T1	17VAC @ 40A Sec 120VAC, 60 Hz Pri	Rectifier duty	W5BWC	
1		Assembly	AC Line Conditioner	PS15C202	
1		Assembly	Regulator	PS15C201	

Material List PS15C202 AC Line Conditioner Assembly

Qty	Designator	Value/Type	Description	Part Number	Supplier
2	C201, C202	0.001uF, 1KV	Disk Ceramic Y5P	140-102P6-102K-RC	
1	F201	5A	5mm X 20mm FA	504-GDB-5A	
1	RT201	2.5/0.06 Ω	Current Limiter	527-CL30	
1	VR201	130VAC MOV	17mm	581-VE17P00131K	
1	Z201	220V, 1500W	Silicon avalanche	625-1.5KE220CA	
1	XF201	5mm X 20mm	PWB Fuse holder	534-4527	
1			PWB	PS15C222	
1		AWG 18X3 5-15P	SVT power cord	173-53101-E	

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Material List PS15C201 Regulator Assembly

Qty	Designator	Value/Type	Description	Part Number	Supplier
1	C101	330uF, 25V	Aluminum	140-XRL25V330	
2	C102, C103	33pF, 50V	X7R Ceramic	140-50N5-330J-RC	
1	C104	0.1uF, 50V	MLC Ceramic	80-C320C104K5R5TA	
1	C105	2200pF, 50V	Metalized Film	581-BQ014D0222J	
1	C106	1.0uF, 50V	Metalized Film	581-BQ074D0105J	
1	C107	4700uF, 16V	Aluminum	140-XRL16V4700	
1	C108	0.001uF, 1 KV	Disk ceramic Y5P	140-102P6-101K-RC	
1	C109	10uF, 16V	Aluminum	140-XRL16V10-RC	
1	D101	1N4003	1A Silicon	821-1N4003	
3	D102, 103, 105	1N4454	Silicon Sw		
1	D104	STPS3045 30A, 45V	Dual Schottky	511-STPS3045CT	
1	F101	30A ATO	Blade fuse	576-0257030.PXPV	
1	Q101	2N3904	Small Sig NPN	863-2N3904G	
1	Q102	2N3906	Small Sig PNP	863-2N3906G	
1	Q103	2N4923	TO-126 NPN Pwr	610-2N4923	
2	R101, 102	20 K Ω , 0.25W, 5%	Carbon Film	291-20K-RC	
1	R103	8.2 K Ω , 0.25W, 5%	Carbon Film	291-8.2K-RC	
1	R104	2 K Ω , 0.25W, 5%	Carbon Film	291-2K-RC	
1	R105	6.8 K Ω , 0.25W, 5%	Carbon Film	291-6.8K-RC	
2	R106, 109	10 K Ω , 0.25W, 5%	Carbon Film	291-10K-RC	
1	R107	0.005 Ω , 5W, 1%	Metal element	588-15FR005E	
1	R108	2.37 K Ω , 0.25W, 1%	Metal Film	271-2.37K-RC	
1	R110	12 K Ω , 0.25W, 5%	Carbon Film	291-12K-RC	
1	R111	200 K Ω , 0.25W, 1%	Metal Film	271-200K-RC	
1	R112	3.6 K Ω , 0.25W, 5%	Carbon Film	291-3.6K-RC	
1	R113	1.5 K Ω , 0.25W, 5%	Carbon Film	291-1.5K-RC	
1	R114	274 K Ω , 0.25W, 1%	Metal Film	271-274K-RC	
1	R115	6.19 K Ω , 0.25W, 1%	Metal Film Film	271-6.19K-RC	
1	R116	10 K Ω , 0.25W, 5%	Cermet variable	652-3386W-1-103LF	
1	R117	21.0 K Ω , 0.25W, 1%	Metal Film	271-21K-RC	
1	R118	5.1 K Ω , 0.25W, 5%	Carbon Film	291-5.1K-RC	
1	R119	470 Ω , 1W, 5%	Carbon Film	281-470-RC	
3	R120, 124, 125	100 Ω , 0.25W, 5%	Carbon Film	291-100-RC	
1	R121	68 Ω , 5W, 5%	Silicone wire wound	71-CW5-68	

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Material List PS15C201 Regulator Assembly

Qty	Designator	Value/Type	Description	Part Number	Supplier
1	R122	1 k Ω , 0.25W, 5%	Carbon Film	291-1K-RC	
1	R123	10 Ω , 0.25W, 5%	Carbon Film	291-10-RC	
2	R126, 127	1.0 Ω , 0.5W, 5%	Carbon Film	293-1.0-RC	
1	U101	LF353	Dual FET Op Amp	LF353NNS-ND	DIGI
1	U102	LM336-2.5	2.5V Shunt Ref	LM336Z-2.5NS-ND	DIGI
2	XF101	ATO Blade fuse	PWB Clip	534-3522	
1	Z101	18V, 1500W	Silicon Avalanche	576-1.5KE22	
1			PWB	PS15C221	

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Theory of operation

Input power is supplied to the PS-15C-2 through the PS15C202 AC Line Conditioner which provides surge protection, transient protection, in-rush current limiting, and RFI/EMI filtering.

To maximize immunity to external interference, the chassis ground is connected to both the DC output negative terminal and power line ground. This necessitates the power be supplied by a grounded AC supply, otherwise the chassis will float up to approximately half the supply voltage.

RT201 limits the in-rush current caused by C2 charging when AC power is first supplied.

The rectified and filtered DC voltage is supplied to the PSC201 regulator assembly and to the pass elements Q1 and Q2 which are in the negative side of the supply. This allows the transistors to mount directly to the grounded heat sink minimizing thermal resistance.

D101 and C101 provide a power-on signal to Q101 which allows the bleeder resistor and other regulator circuits to be disconnected when AC power is off. This enables the power supply to draw less than 1 mA from an external secondary battery, preventing discharging during power off conditions. Note that C101 and R101 provide a 30 second delay before turn-off occurs. This ensures R121 has time to discharge C2 before the circuit disconnects it. If an external battery is connected this will cause the ON LED to stay on for about 30 seconds after AC power is off.

Q102 and associated circuitry also detect the condition of F101 and the presence of AC power. So if D1 is on, it indicates AC power is present (F201 good) and that the DC fuse is good and functions properly with or without an external battery connected. Thus the status of the power supply is not hidden by the external DC voltage that may be present.

The Status output at J1 provides this function externally so that two LEDs can be connected to indicate if the power supply is providing current to the load or if the external battery is.

U101 is a dual FET Op Amp providing voltage regulation and current limiting. D102 and D103 act as a analog "OR" circuit allowing automatic switching from voltage regulation to current regulation. U102 is a precision 2.5 V shunt reference that establishes the operation point for both voltage and current regulation.

The resistor network and C109 associated with U101B comprise dual mode current limiting. For normal overloads, or short duration current surges - e.g. an incandescent filament - C109 allows U101B to function as a constant current regulator. For longer lasting overloads or a short circuit, R114 causes the output current to fold back to approximately 5 A.

Output reverse voltage and transient protection is provided by D104 and Z101. C108 provides RF filtering. The PS15C201 assembly is mounted directly on, and supported by, copper straps under the 0.25" brass output bolts.

Cooling is provided by a 100 CFM thermostatically controlled fan EM1.

