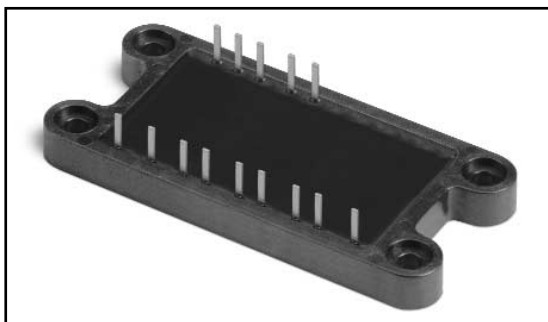


# MODEL 7700 SERIES

## Power Factor Correction Power Module

**NEW HIGHER POWER VERSION**



### MODELS/RANGE

7700B	1,500 Watts / 3,000 Watts
7700-2A	2,000 Watts / 4,000 Watts

### FEATURES AND BENEFITS

- Module contains all power components necessary to provide power factor correction in a switching power supply.
  - Rectifier bridge with SCRs for inrush current limiting
  - Ultrafast platinum output diode
  - 500V .1 $\Omega$  Max. FET (7700B)
  - Low gate charge, 500V, .0675 $\Omega$  max. FET (7700-2A)
- Provides optimum use of available line current
- Allows power supply to meet harmonic requirement
- Module design reduces cost of heat sink
- Saves significant space and assembly time
- Low cost
- Internal temperature sensing
- Replaces up to 10 each TO-220 or TO-247 discrete power semiconductors
- Custom module versions available to meet specific requirements such as:
  - Motor drives
  - Power servo amplifiers
  - Solenoid drivers
  - Solid state relays
  - 3 phase rectifier bridges

### APPLICATIONS

Designed to optimally facilitate a boost type power factor correction (PFC) system for designs with up to 36A rms input current.

Specifications subject to change without notice.

Standard applications include switching power supplies from 1,000 watts to 4,000 watts with line voltages up to 300 V rms.

# ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Conditions <sup>1</sup>	Model	Min.	Typ.	Max.	Units
<b>MOS FET</b>							
Continuous Drain Current	$I_D$	$T_C = 25^\circ\text{C}$	B			56	A
			-2A			80	A
		$T_C = 100^\circ\text{C}$	B			34.8	A
			-2A			48	A
Pulsed Drain Current	$I_{DM}$		B			224	A
			-2A			320	A
Single Pulse Avalanche Energy	$E_{AS}$		B			760	mJ
			-2A			960	mJ
Repetitive Avalanche Energy	$E_{AR}$		B			19	mJ
			-2A			28	mJ
Avalanche Current	$I_{AR}$		B			8.7	A
			-2A			20	A
Gate to Source Voltage	$V_{GS}$		B, -2A			$\pm 30$	V
Leakage Current	$I_{DSS}$	$V_{GS} = 0\text{V}, V_{DS} = 500\text{V}$	B, -2A			100	$\mu\text{A}$
Drain to Source ON Voltage	$V_{DS(ON)}$	$I_C = 28\text{A}, V_{GS} = 10\text{V}$	B	1.5		2.8	V
			-2A	1.0		2.7	V
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{DS} = V_{GS}, I_D = 1\text{mA}$	B, -2A	2.0		4.0	V
Gate Leakage Current	$I_{GSS}$	$V_{GS} \pm 20\text{V}$	B, -2A			$\pm 400$	nA
Total Gate Charge	$Q_g$	$I_D = 56\text{A}, V_{DS} = 400\text{V}$	B			600	nC
Gate Source Charge	$Q_{gs}$	$V_{GS} = 10\text{V}$	B			80	nC
Gate Drain (Miller) Charge	$Q_{gd}$		B			320	nC
Total Gate Charge	$Q_g$	$I_D = 80\text{A}, V_{DS} = 400\text{V}$	-2A			480	nC
Gate Source Charge	$Q_{gs}$	$V_{GS} = 10\text{V}$	-2A			128	nC
Gate Drain (Miller) Charge	$Q_{gd}$		-2A			196	nC
Continous Source Current (Body Diode)	$I_S$		B			56	A
			-2A			80	A
Pulsed Source Current (Body Diode)	$I_{SM}$		B			224	A
			-2A			320	A
Body Diode Forward Voltage	$V_{SD}$	$I_S = 56\text{A}, V_{GS} = 0\text{V}$	B	0.4		1.4	V
		$I_S = 80\text{A}, V_{GS} = 0\text{V}$	-2A	0.5		1.8	V
Reverse Recovery Time (Body Diode)	$t_{rr}$	$I_F = 56\text{A}, di/dt = 400\text{A}/\mu\text{s}$	B			810	ns
		$I_F = 80\text{A}, di/dt = 400\text{A}/\mu\text{s}$	-2A			860	ns
Reverse Recovery Charge (Body Diode)	$Q_{rr}$	$I_F = 56\text{A}, di/dt = 400\text{A}/\mu\text{s}$	B			28.8	ns
		$I_F = 80\text{A}, di/dt = 400\text{A}/\mu\text{s}$	-2A			39.6	ns
Internal Gate Resistor	$R_G$		B		1.25		$\Omega$
			-2A		0.25		$\Omega$
Junction Temperature	$T_J$		B, -2A			150	$^\circ\text{C}$
Thermal Resistance	$R_{THJC}$		B		0.20	.025	$^\circ\text{C}/\text{W}$
			-2A		.15	.20	$^\circ\text{C}/\text{W}$

# ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Conditions <sup>1</sup>	Model	Min.	Typ.	Max.	Units
<b>SCRS</b>							
Average On Current	$I_{T(AV)}$	$T_C = 75^{\circ}\text{C}$ , 180° half sine wave	B			20	A
			-2A			35	A
RMS On Current (As AC switch)	$I_{RMS}$		B			30	A
			-2A			55	A
Peak Repetitive Off Voltage	$V_{RRM}/$ $V_{DRM}$		B			600	V
			-2A			800	V
Peak One Cycle Non-Repetitive Surge Current	$I_{TSM}$	$T_J = T_{J\text{Max.}}$ , $t = 10\text{ms}$ (50 Hz), sine	B			300	A
			-2A			400	A
Reverse and Direct Leakage Current	$I_R/I_D$	$V_R = V_{RRM}$ , $V_D = V_{DRM}$	B			25	$\mu\text{A}$
			-2A			300	$\mu\text{A}$
On Voltage	$V_T$	$I_T = 25\text{A}$	B	0.5		1.6	V
		$I_T = 45\text{A}$	-2A	0.5		1.6	V
Gate Trigger Voltage (Includes drop across $R_G$ )	$V_{GT}$	$V_D = 6\text{V}$ , $22\Omega$	B, -2A	0.2		3.5	V
		$V_D = 6\text{V}$ , $22\Omega$ . $T_J = -40^{\circ}\text{C}$	B, -2A	0.3		1.5	V
		$V_D = 6\text{V}$ , $22\Omega$ . $T_J = 125^{\circ}\text{C}$	B, -2A	0.1		1.5	V
Gate Trigger Current (Each SCR Individually)	$V_{GT}$	$V_D = 6\text{V}$ , $22\Omega$	B, -2A	5		60	mA
		$V_D = 6\text{V}$ , $22\Omega$ . $T_J = -40^{\circ}\text{C}$	B, -2A	10		120	mA
		$V_D = 6\text{V}$ , $22\Omega$ . $T_J = 125^{\circ}\text{C}$	B, -2A	2		35	mA
Holding Current	$I_H$	(Each SCR Individually)	B			100	mA
			-2A			100	mA
Internal Gate Resistor	$R_G$	Connected to each SCR	B		10		$\Omega$
			-2A		10		$\Omega$
Junction Temperature	$T_J$		B, -2A			150	$^{\circ}\text{C}$
Thermal Resistance	$R_{thjc}$		B		1.4	2.0	$^{\circ}\text{C/W}$
			-2A		0.7	1.0	$^{\circ}\text{C/W}$
<b>Bridge Diodes</b>							
Average Forward Current	$I_{F(AV)}$	$T_C = 105^{\circ}\text{C}$ , 180°, half sine wave	B			20	A
			-2A			40	A
Peak Repetitive Reverse Voltage	$V_{RRM}$		B			600	V
			-2A			800	V
Peak One Cycle Non-Repetitive Surge Current	$I_{FSM}$	$T_J = T_{J\text{Max.}}$ , $t = 10\text{ms}$ (50 Hz), sine	B			300	A
			-2A			400	A
Reverse Leakage Current	$I_R/$	$V_R = V_{RRM}$	B			100	$\mu\text{A}$
			-2A			300	$\mu\text{A}$
Forward Voltage	$V_F$	$I_F = 25\text{A}$	B	0.5		1.2	V
		$I_F = 40\text{A}$	-2A	0.5		1.2	V
Junction Temperature	$T_J$		B, -2A			150	$^{\circ}\text{C}$
Thermal Resistance	$R_{THJC}$		B		1.5	1.8	$^{\circ}\text{C/W}$
			-2A		1.0	1.2	$^{\circ}\text{C/W}$

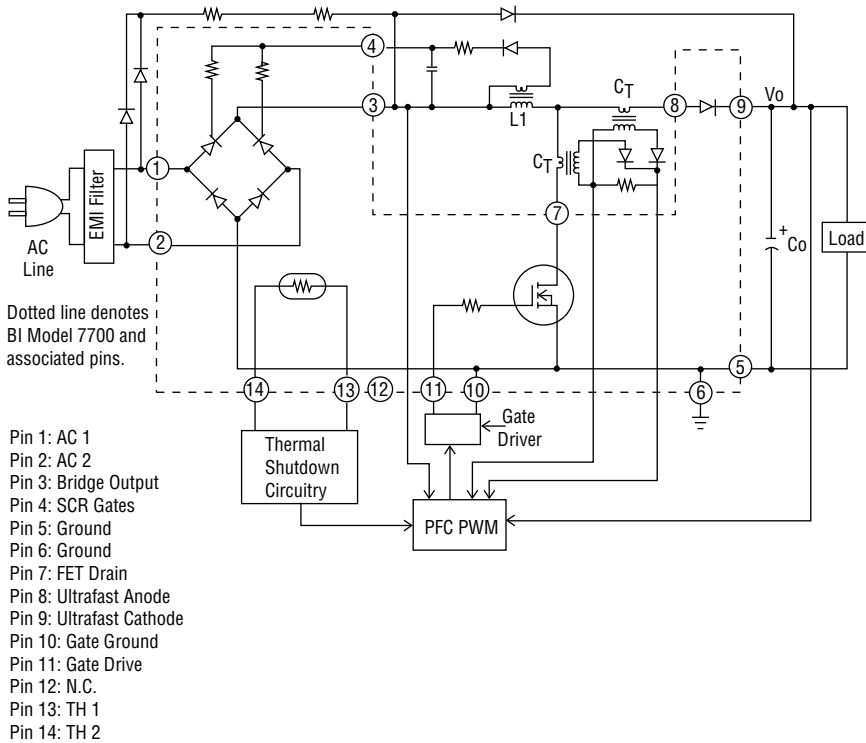


# ELECTRICAL CHARACTERISTICS

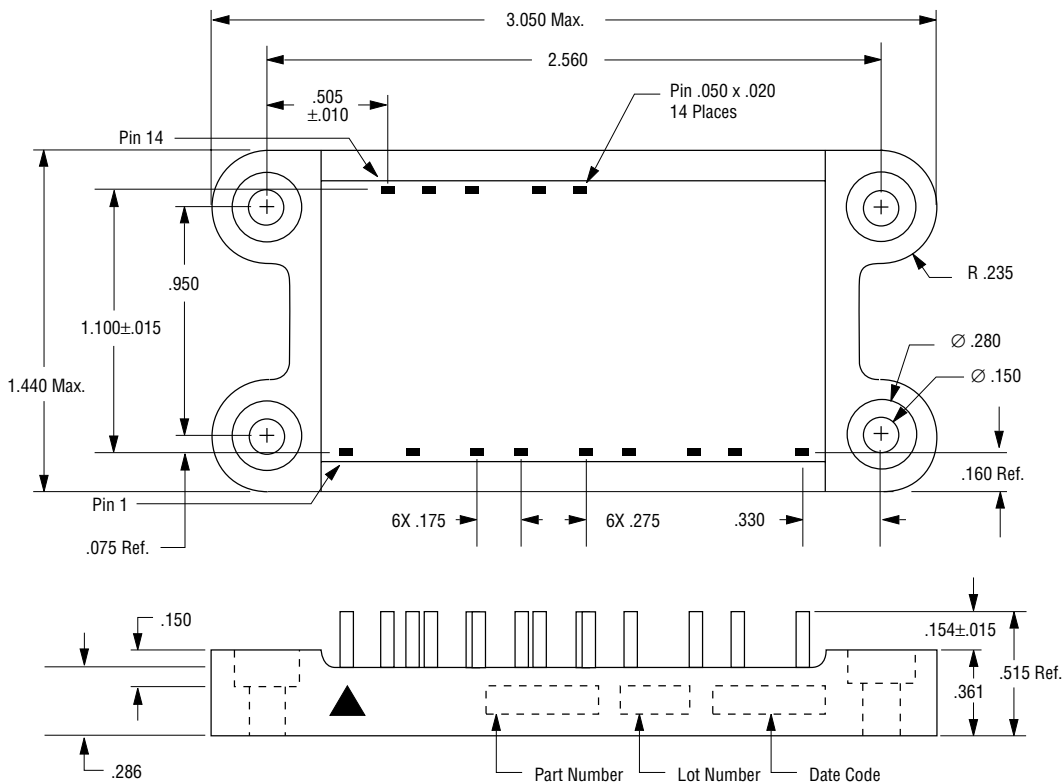
Parameter	Symbol	Conditions <sup>1</sup>	Model	Min.	Typ.	Max.	Units
<b>Output Diode</b>							
Average Forward Current	$I_{F(AV)}$	$T_C = 120^{\circ}\text{C}$	B			24	A
			-2A			60	A
Peak Repetitive Reverse Voltage	$V_{RRM}$		B, -2A			600	V
Peak One Cycle Non-Repetitive Surge Current	$I_{FSM}$	$T_J = T_{JMax.}$ , $t = 10\text{ms}$ (50 Hz), sine	B			500	A
			-2A			500	A
Reverse Leakage Current	$I_R$	$V_R = V_{RRM}$	B			60	$\mu\text{A}$
			-2A			1	mA
Forward Voltage	$V_F$	$I_F = 24\text{A}$	B	1.0		2.8	V
		$I_F = 50\text{A}$	-2A	0.5		2.8	V
Reverse Recovery Time	$t_{rr}$	$I_F = 6\text{A}$ , $di/dt = 300\text{A}/\mu\text{s}$	B			35	ns
		$I_F = 2\text{A}$ , $di/dt = 200\text{A}/\mu\text{s}$	-2A			40	ns
Junction Temperature	$T_J$		B, -2A			175	$^{\circ}\text{C}$
Thermal Resistance	$R_{THJC}$		B		0.9	1.0	$^{\circ}\text{C}/\text{W}$
			-2A		0.75	0.9	$^{\circ}\text{C}/\text{W}$
<b>TH1 NTC Thermistor</b>							
Resistance	$R_{25}$	$I = 1\text{mA}$	B, -2A	22.5	25	27.5	$\text{K}\Omega$
Resistance Ratio	$R_T/R_{25}$	$T = 80^{\circ}\text{C}$	B, -2A	.126			
		$T = 90^{\circ}\text{C}$	B, -2A	.0916			
		$T = 100^{\circ}\text{C}$	B, -2A	.0679			
		$T = 110^{\circ}\text{C}$	B, -2A	.0511			
Dissipation Constant	$P_D$		B, -2A		1.0		$\text{mW}/^{\circ}\text{C}$
Thermal Time Constant	$t$		B, -2A			10	sec

1 -  $T_{Case} = 25^{\circ}\text{C}$  unless otherwise specified.

## SYSTEM DIAGRAM



## OUTLINE DIMENSIONS (Inch)



## ORDERING INFORMATION

Model 77 0 0 B

Package \_\_\_\_\_

Range, Watts:  
 B = 1,500 to 3,000 Watts  
 -2A = 2,000 to 4,000 Watts

Circuit Function:  
 0 = Power Factor Correction

## OUTPUT VOLTAGE

The dc output voltage must be greater than the highest peak line voltage expected:

$$V_0 > V_{IN\ MAX} \times 1.414$$

## DISCONTINUOUS CONDUCTION

When the line voltage approaches zero volts the PFC PWM will be forced towards its maximum duty cycle. This will cause the current to become discontinuous, which will result in some distortion. The line voltage at which the current will become discontinuous will be:

$$V_{IN\ discontinuous} = \frac{V_0 \times (1 - DC_{MAX})}{DC_{MAX}}$$

The line voltage at which the PWM will be duty cycle limited will be:

$$V_{IN\ duty\ cycle\ limited} = V_0 \times (1 - DC_{MAX})$$

## INDUCTOR L1

The inductor value controls the amplitude of the 100KHz current ripple. This can greatly effect the amount of distortion and thus the amount of EMI filtering required on the input. Ripple current can be calculated for any point along the input sine wave:

$$I_{P-P}(t) = \frac{V_{IN}(t) \times DC(t)}{L \times f}$$

Where:  $DC(t) = 1 - V_{IN}(t)/V_0$ , L is the inductance of L1, and f is the switching frequency.

A good starting point would be to set Ip-p equal to 20% of the 120 Hz peakcurrent, solving for L:

$$L \geq \frac{5 \times V_{IN}^2 \times (1 - \frac{1.414 \times V_{IN}}{V_0})}{P_{IN} \times f}$$

## OUTPUT CAPACITOR

The output capacitor size is often limited by the line dropout requirements of the power supply:

$$C_0\ MIN = \frac{2 \times P_{OUT} \times t_d}{V_0^2 - V_0\ MIN^2}$$

Where:  $P_{OUT}$  is the output power,  $t_d$  is the dropout time, and  $V_0\ MIN$  is the minimum allowed output voltage.

The 120Hz output voltage ripple can be calculated to insure it meets the system requirements:

$$V_0\ P-P\ 120 = \left( \frac{2 \times P_0}{V_0} \right) \times \left( \frac{1}{2 \times \pi \times f \times C_0} + ESR \right)$$

The maximum rms 120Hz ripple current will be:

$$I_{RMS\ 120} = \frac{1.414 \times P_0}{V_0}$$

The 100KHz output voltage ripple will be:

$$V_0\ P-P\ 100K = \frac{V_{IN} \times (1 - \frac{1.414 \times V_{IN}}{V_0})}{L \times f} \times \left( \frac{1}{2 \times \pi \times f \times C_0} + ESR \right)$$

The maximum rms 100KHz ripple current will be:

$$I_{RMS\ 100K} = \frac{V_{IN} \times (1 - \frac{1.414 \times V_{IN}}{V_0})}{2.828 \times L \times f}$$

## GATE DRIVE REQUIREMENTS

FET switching times must be fast enough to insure that the FET turns off when the PWM is at maximum duty cycle. Snubbing circuits across the FET will slow the turn off time and should not be used.

A discrete gate driver circuit will allow the fastest possible switching times. The Unitrode UC3710 or Telcom TC4422 drivers offer a single chip approach

with only slightly slower switching times. The gate driver must be located as close to the module as possible. Ground sense pin 10 should be used to insure the fastest possible switching times.

#### **HEAT RADIATOR**

The heat radiator requirements can be determined by the maximum power dissipated (at low line) and the maximum ambient temperature. The back side of the module should be limited to about 100°C by utilizing the internal thermistor.

$$R_{\theta} = \frac{100 - T_{MAX\ AMB}}{P_{LOWLINE}}$$

Care should be used when attaching the module to the heat radiator. The screws must be tightened incrementally in a crisscross pattern. A torque limiting screwdriver should be used.

The high current levels require current sense transformers to maintain a reasonable efficiency. We recommend BI Technologies HM31-20200.

#### **PFC PWM VENDORS**

Popular sources are:

Unitrode UC3854

Micro Linear ML4812

Linear Technology LT1248