

This device contains 240 active transistors.

Figure 1. Representative Block Diagram

MAXIMUM RATINGS (T_A = 25°C, unless otherwise noted)

Rating	Symbol	Value	Unit
Power Supply Voltage (Transient)	V _{CC}	20	V
Power Supply Voltage (Operating)	V _{CC}	16	V
Line Voltage	V _{Line}	500	V
Current Sense, Multiplier, Compensation, Voltage Feedback, Restart Delay and Zero Current Input Voltage	V _{in1}	-1.0 to +10	V
LEB Input, Frequency Clamp Input	V _{in2}	-1.0 to +20	V
Zero Current Detect Input	I _{in}	±5.0	mA
Restart Diode Current	I _{in}	5.0	mA
Power Dissipation and Thermal Characteristics D Suffix, Plastic Package Case 751K Maximum Power Dissipation @ T _A = 70°C Thermal Resistance, Junction–to–Air	P_{D} $R_{ heta JA}$	450 178	mW °C/W
Operating Junction Temperature	TJ	150	°C
Operating Ambient Temperature	T _A	-25 to +125	°C
Storage Temperature Range	T _{stg}	−55 to +150	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

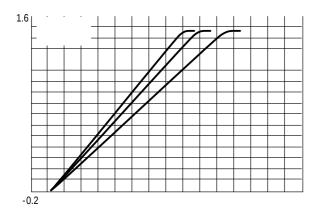
NOTE: ESD data available upon request.

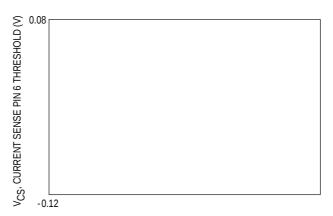
$\textbf{ELECTRICAL CHARACTERISTICS} \ \ (V_{CC} = 14.5 \ V, \ \, \text{for typical values T}_{A} = 25 ^{\circ}\text{C}, \ \, \text{for min/max values T}_{J} = -25 \ \, \text{to } + 125 ^{\circ}\text{C})$

Characteristic	Symbol	Min	Тур	Max	Unit
ERROR AMPLIFIER					
Input Bias Current (V _{FB} = 5.0 V)	I _{IB}	-	0	1.0	μΑ

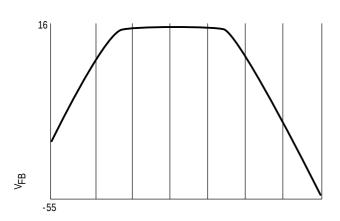
$\textbf{ELECTRICAL CHARACTERISTICS (continued)} \ (V_{CC} = 14.5 \ \text{V}, \ \text{for typical values} \ T_{A} = 25^{\circ}\text{C}, \ \text{for min/max values} \ T_{J} = -25 \ \text{to} \ +125^{\circ}\text{C})$

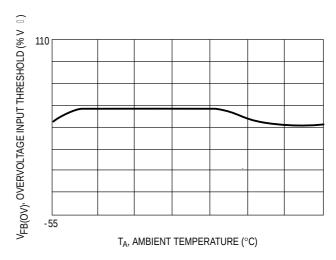
Characteristic	Symbol	Min	Тур	Max	Unit
DRIVE OUTPUT					
Source Resistance (Current Sense = 0 V, $V_{Gate} = V_{CC} - 1.0 V$) Sink Resistance (Current Sense = 3.0 V, $V_{Gate} = 1.0 V$)	R _{OH} R _{OL}				

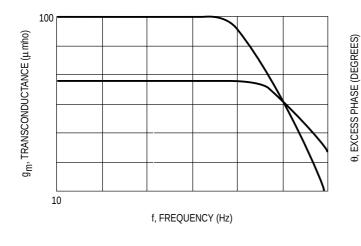


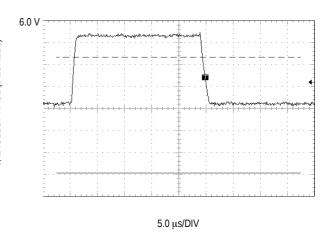


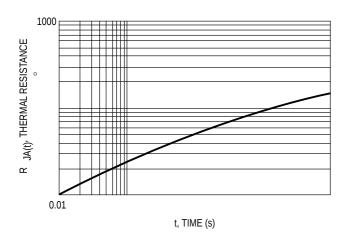
V_M, MULTIPLIER PIN 5 INPUT VOLTAGE (V)











FUNCTIONAL DESCRIPTION

INTRODUCTION

Multiplier

A single quadrant, two input multiplier is the critical element that enables this device to control power factor. The ac haversines are monitored at Pin 5 with respect to ground while the Error Amplifier output at Pin 4 is monitored with respect to the Voltage Feedback Input threshold. A graph of the Multiplier transfer curve is shown in Figure 2. Note that both inputs are extremely linear over a wide dynamic range, 0 to 3.2 V for Pin 5 and 2.5 to 4.0 V for Pin 4. The Multiplier output controls the Current Sense Comparator threshold as the ac voltage traverses sinusoidally from zero to peak line. This has the effect of forcing the MOSFET on—time to track the input line voltage, thus making the preconverter load appear to be resistive.

Zero Current Detector

The MC33368 operates as a critical conduction current mode controller, whereby output switch conduction is initiated by the Zero Current Detector and terminated when the peak inductor current reaches the threshold level established by the Multiplier output. The Zero Current Detector initiates the next on—time by setting the $R_{\rm S}$ Latch at the instant the inductor current reaches zero. This critical conduction mode of operation has two significant benefits. First, since the MOSFET cannot turn—on until the inductor current reaches zero, the output rectifier's reverse recovery time becomes less critical allowing the use of an inexpensive rectifier. Second, since there are no deadtime gaps between cycles, the ac line current is continuous thus limiting the peak switch to twice the average input current

The Zero Current Detector indirectly senses the inductor current by monitoring when the auxiliary winding voltage falls below 1.2 V. To prevent false tripping, 200 mV of hysteresis is provided. The Zero Current Detector input is internally protected by two clamps. The upper 10 V clamp prevents input overvoltage breakdown while the lower $-0.7\,\mathrm{V}$ clamp prevents substrate injection. An external resistor must be used in series with the auxiliary winding to limit the current through the clamps to 5.0 mA or less.

Current Sense Comparator and RS Latch

The Current Sense Comparator R_S Latch configuration used ensures that only a single pulse appears at the Drive Output during a given cycle. The inductor current is converted to a voltage by inserting a ground–referenced sense resistor R7 in series with the source of output switch. This voltage is monitored by the Current Sense Input and compared to a level derived from the Multiplier output. The peak inductor current under normal operating conditions is controlled by the threshold voltage of Pin 6 where:

$$I_{pk}$$
 Pin 6 Threshold R7

Abnormal operating conditions occur when the preconverter is running at extremely low line or if output

voltage sensing is lost. Under these conditions, the Current Sense Comparator threshold will be internally clamped to 1.5 V. Therefore, the maximum peak switch current is:

$$I_{pk(max)}$$
 $\frac{1.5 \text{ V}}{R7}$

With the component values shown in Figure 16, the Current Sense Comparator threshold, at the peak of the haversine, varies from 110 mV at 90 Vac to 100 mV at 268 Vac. The Current Sense Input to Drive Output propagation delay is typically 200 ns.

Timer

A watchdog timer function was added to the IC to eliminate the need for an external oscillator when used in stand alone applications. The Timer provides a means to automatically start or restart the preconverter if the Drive Output has been off for more than 385 μ s after the inductor current reaches zero.

Undervoltage Lockout and Quickstart

The MC33368 has a 5.0 V internal reference brought out to Pin 1 and capable of sourcing 10 mA typically. It also contains an Undervoltage Lockout (UVLO) circuit which suppresses the Gate output at Pin 11 if the V_{CC} supply voltage drops below 8.5 V typical.

A Quickstart circuit has been incorporated to optimize converter startup. During initial startup, compensation capacitor C1 will be discharged, holding the Error Amplifier output below the Multiplier's threshold. This will prevent Drive Output switching and delay bootstraping of capacitor C4 by diode D6. If Pin 4 does not reach the multiplier threshold before C4 discharges below the lower SMPS UVLO threshold, the converter will hiccup and experience a significant startup delay. The Quickstart circuit is designed to precharge C1 to 1.7 V. This level is slightly below the Pin 4 Multiplier threshold, allowing immediate Drive Output switching.

Restart Delay

A restart delay pin is provided to allow hiccup mode fault protection in case of a short circuit condition and to prevent the SMPS from repeatedly trying to restart after the input line voltage has been removed. When power is first applied, there is no startup delay, but subsequent cycling of the $V_{\rm CC}$ voltage will result in delay times that are programmed by an external resistor and capacitor. The Restart Delay, Pin 2, is a high impedance, so that an external capacitor can provide delay times as long as several seconds.

If the SMPS output is short circuited, the transformer winding, which provides the V_{CC} voltage to the control IC and the MC33368, will be unable to sustain V_{CC} to the control circuits. The restart delay capacitor at Pin 2 of the MC33368 prevents the high voltage startup transistor within the IC from maintaining the voltage on C4. After V_{CC} drops below the UVLO threshold in the SMPS, the SMPS switching transistors are held off for the time programmed by the values of the restart capacitor (C9) and resistor (R8).



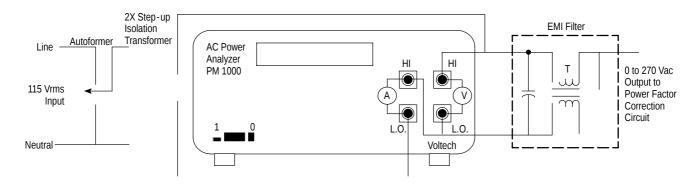
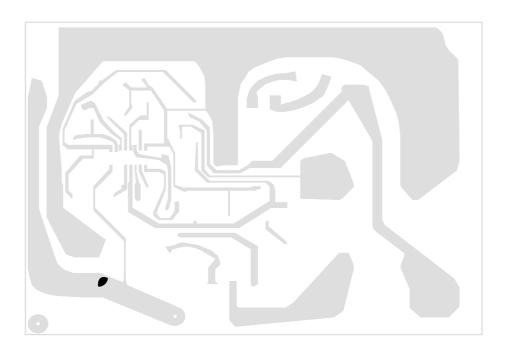


Figure 18. Power Factor Test Setup

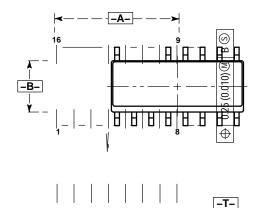




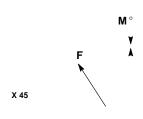


SOIC-16 MINUS PINS 14, 15 CASE 751K **ISSUE O**

DATE 22 DEC 1993



⊕ 0.25 (0.010) M T A S B S



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI
- Y14.5M, 1982. CONTROLLING DIMENSION: MILLIMETER.
- DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
- MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
- 5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
Α	9.80	10.00	0.368	0.393
В	3.80	4.00	0.150	0.157
С	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0 °	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

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DESCRIPTION:	SOIC-16 MINUS PINS 14,15		PAGE 1 OF 1

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