



# High-Frequency Switchmode Controller

## FEATURES

- 15- to 200-V Input Range
- Current-Mode Control
- Internal Start-Up Circuit
- Latched SHUTDOWN
- Soft-Start
- 1.8-MHz Error Amp

## DESCRIPTION

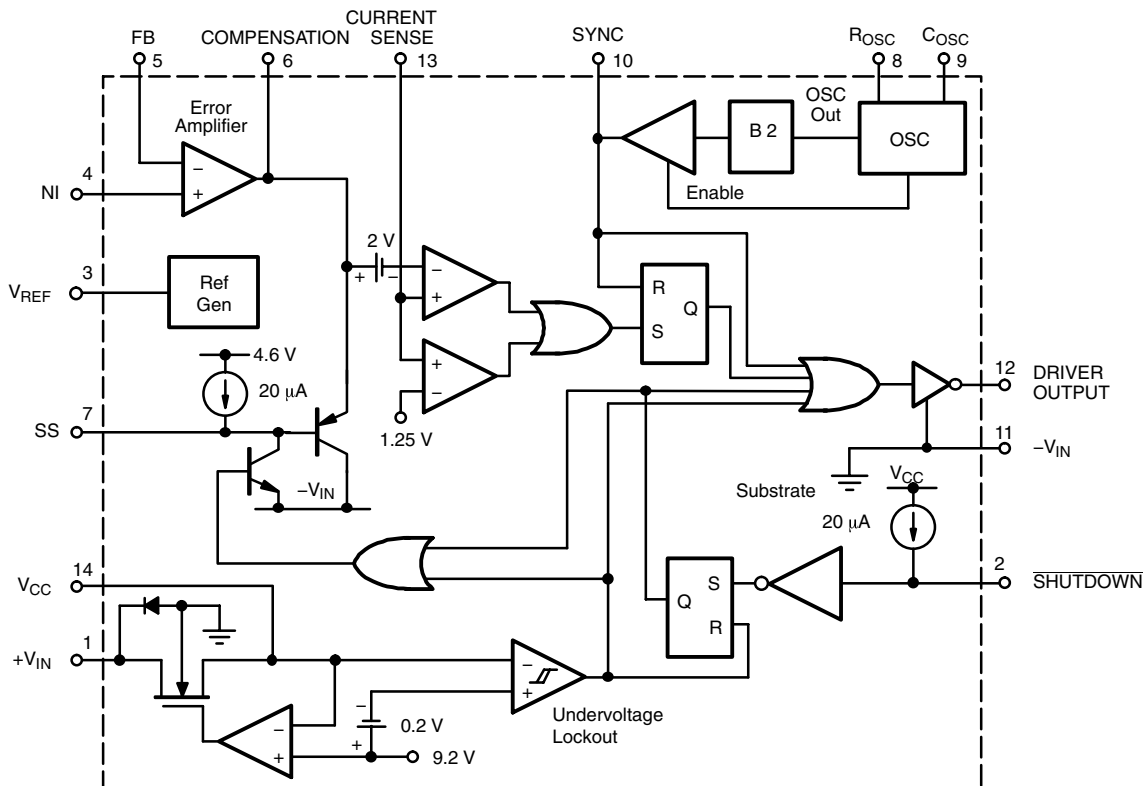
The Si9114A is a BiC/DMOS current-mode pulse width modulation (PWM) controller IC for high-frequency dc/dc converters. Single-ended topologies (forward and flyback) can be implemented at frequencies up to 1 MHz. The oscillator has an internal divide-by-two that limits the duty ratio to 50%. An oscillator sync output allows converters to be synchronized in phase as well as in frequency, in a master/slave configuration.

The high-voltage DMOS transistor allows the IC to interface directly to bus voltages up to 200 V. Other features include a 1.5% accurate voltage reference, 1.8-MHz (min) bandwidth error amplifier, shutdown logic control, soft-start and undervoltage lockout circuits.

The output inverter can typically source 500 mA and sink 700 mA. Shoot-through current is all but eliminated to minimize supply current requirements.

The Si9114A is available in both standard and lead (Pb)-free 14-pin plastic DIP and SOIC packages, and is specified over the industrial, D suffix (-40°C to 85°C) temperature range.

## FUNCTIONAL BLOCK DIAGRAM





## ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to $-V_{IN}$	
$V_{CC}$ .....	18 V
$+V_{IN}$ (Note: $V_{CC} < +V_{IN} + 0.3$ V) .....	200 V
Logic Input (SHUTDOWN, SYNC) .....	-0.3 V to $V_{CC} + 0.3$ V
Linear Inputs (FEEDBACK, SENSE, SOFT-START) .....	-0.3 V to $V_{CC} + 0.3$ V
HV Pre-Regulator Input Current (continuous) .....	5 mA
Storage Temperature .....	-65 to 150°C
Operating Temperature .....	-40 to 85°C
Junction Temperature ( $T_J$ ) .....	150°C

Power Dissipation (Package)a	
14-Pin Plastic Dip (J Suffix)b .....	750 mW
14-Pin SOIC (Y Suffix)c .....	900 mW
Thermal Impedance ( $\Theta_{JA}$ )	
14-Pin Plastic Dip .....	167°C/W
14-Pin SOIC .....	140°C/W

### Notes

- Device mounted with all leads soldered or welded to PC board.
- Derate 6 mW/°C above 25°C.
- Derate 7.2 mW/°C above 25°C.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## RECOMMENDED OPERATING RANGE

Voltages Referenced to $-V_{IN}$	
$V_{CC}$ .....	9.5 V to 16.5 V
$+V_{IN}$ .....	15 V to 200 V
$f_{OSC}$ .....	20 kHz to 2 MHz

$R_{OSC}$ .....	56 k $\Omega$ to 1 M $\Omega$
$C_{OSC}$ .....	47 pF to 200 pF
Linear Inputs .....	0 to $V_{CC} - 4$ V
Digital Inputs .....	0 to $V_{CC}$

SPECIFICATIONS						
Parameter	Symbol	Test Conditions Unless Otherwise Specified Oscillator Disabled $-V_{IN} = 0$ V, $V_{CC} = 10$ V	Limits D Suffix -40 to 85°C			Unit
			Min <sup>a</sup>	Typ <sup>b</sup>	Max <sup>a</sup>	
<b>Reference</b>						
Output Voltage	$V_R$	OSC Disabled, $T_A = 25^\circ\text{C}$	3.94	4.0	4.06	V
		OSC Disabled Over Voltage and Temperature Ranges <sup>c</sup>	3.88	4.0	4.12	
Short Circuit Current	$I_{SREF}$	$V_{REF} = -V_{IN}$		-30	-5	mA
Load Regulation	$\Delta V_R / \Delta I_R$	$I_{REF} = 0$ to -1 mA		10	40	mV
<b>Oscillator</b>						
Initial Accuracy	$f_{OSC}^d$	$R_{OSC} = 374$ k $\Omega$ , $C_{OSC} = 200$ pF	90	100	110	kHz
		$R_{OSC} = 70$ k $\Omega$ , $C_{OSC} = 200$ pF	450	500	550	
Voltage Stability <sup>c</sup>	$\Delta f/f$	$R_{OSC} = 70$ k $\Omega$ , $C_{OSC} = 200$ pF $\Delta f/f = [f(16.5 \text{ V}) - f(9.5 \text{ V})] / f(9.5 \text{ V})$		4	7	%
Temperature Coefficient <sup>c</sup>	OSC TC	$-40 \leq T_A \leq 85^\circ\text{C}$ , $f_{OSC} = 100$ kHz		200	500	ppm/°C
Sync Output Current (Master Mode)	$I_{SYNC(M)}$	$V_{ROSC} \leq 5$ V	$\pm 1.0$	$\pm 3.0$		mA
Sync Output Current (Slave Mode)	$I_{SYNC(S)}$	$V_{ROSC} = V_{CC}$		$\pm 1$	$\pm 500$	nA
<b>Error Amplifier (<math>C_{OSC} = -V_{IN}</math> OSC Disabled)</b>						
Input BIAS Current	$I_{FB}$	$V_{FB} = 5$ V, $I_I = V_{REF}$		<1.0	$\pm 200$	nA
Input OFFSET Voltage	$V_{OS2}$			$\pm 5$	$\pm 25$	mV
Open Loop Voltage Gain <sup>c</sup>	$A_{VOL}$		65	80		dB
Unity Gain Bandwidth <sup>c</sup>	BW		1.8	2.7		MHz
Output Current	$I_{OUT}$	Source ( $V_{FB} = 3.5$ V, $I_I = V_{REF}$ )		-2.7	-1.0	mA
		Sink ( $V_{FB} = 4.5$ V, $I_I = V_{REF}$ )	1.0	2.4		
Power Supply Rejection	PSRR	$9.5 \text{ V} \leq V_{CC} \leq 16.5 \text{ V}$	50	80		dB

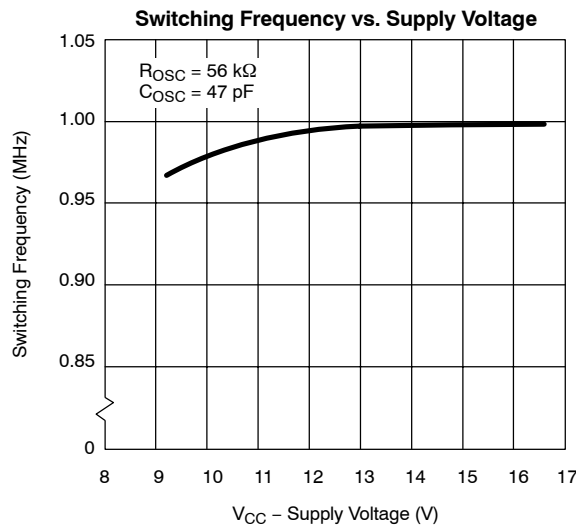
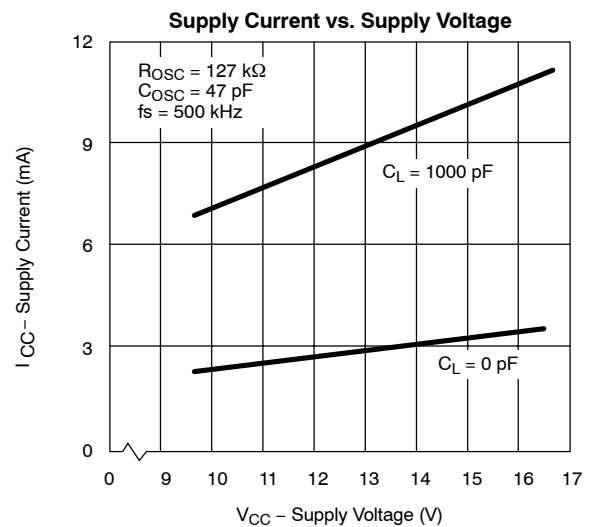
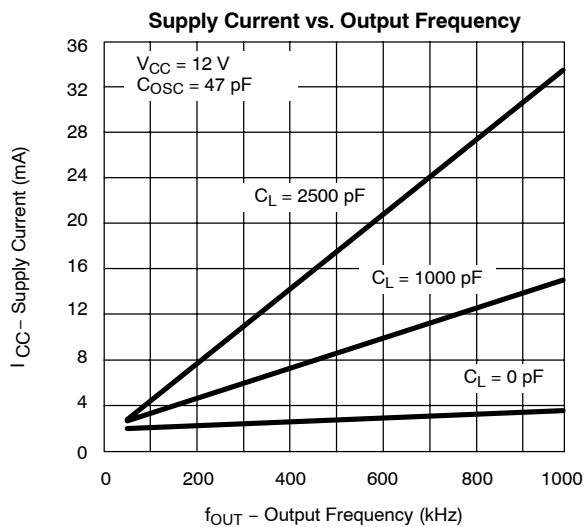
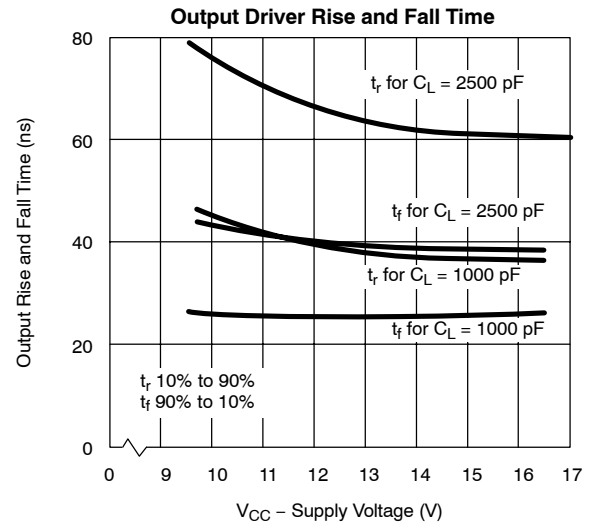
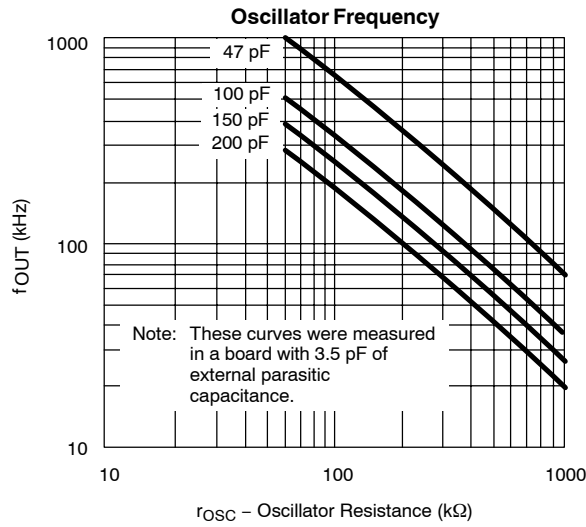


SPECIFICATIONS							
Parameter	Symbol	Test Conditions Unless Otherwise Specified Oscillator Disabled -V <sub>IN</sub> = 0 V, V <sub>CC</sub> = 10 V	Limits D Suffix -40 to 85°C			Unit	
			Min <sup>a</sup>	Typ <sup>b</sup>	Max <sup>a</sup>		
<b>Pre-Regulator/Start-Up</b>							
Input Leakage Current	+I <sub>IN</sub>	+V <sub>IN</sub> = 200 V, V <sub>CC</sub> ≥ 10 V		< 1	10	μA	
Pre-Regulator Start-Up Current	I <sub>START</sub>	+V <sub>IN</sub> = 48 V, t <sub>PW</sub> ≤ 300 μs, V <sub>CC</sub> = V <sub>UVLO</sub>	8	20		mA	
V <sub>CC</sub> Pre-Regulator Voltage	V <sub>PR</sub>	+V <sub>IN</sub> = 48 V	8.8	9.1	9.4	V	
V <sub>PR</sub> -V <sub>UVLO</sub> (Turn-On)	V <sub>DELTA</sub>		0.1	0.25	0.7		
Undervoltage Lockout Hysteresis	V <sub>HYST</sub>		0.18	0.28	0.4		
<b>Supply</b>							
Supply Current	I <sub>CC</sub>	C <sub>LOAD</sub> ≤ 50 pF	f <sub>OSC</sub> = 100 kHz		1.5	2.5	mA
			f <sub>OSC</sub> = 500 kHz		2.2	3.0	
<b>Protection</b>							
Current Limit Threshold Voltage	V <sub>SENSE</sub>	V <sub>FB</sub> = 0 V, NI = V <sub>REF</sub>	1.15	1.23	1.30	V	
Current Limit Delay to Output <sup>c</sup>	t <sub>d</sub>	V <sub>SENSE</sub> = 1.5 V, See Figure 1		77	100	ns	
SHUTDOWN Logic Threshold	V <sub>SD</sub>			2.8	0.5	V	
SHUTDOWN Delay to Latched Output <sup>c</sup>	t <sub>SD</sub>	See Figure 2		0.20	1.0	μs	
SHUTDOWN Pull-Up Current	I <sub>SD</sub>	V <sub>SD</sub> = 0 V	12	23	30	μA	
Soft-Start Current	I <sub>SS</sub>		12	23	30		
Output Inhibit Voltage	V <sub>SS(off)</sub>	Soft-Start Voltage to Disable Driver Output		1.6	0.5	V	
<b>MOSFET Driver</b>							
Output High Voltage	V <sub>OH</sub>	I <sub>OUT</sub> = -10 mA	9.85	9.9		V	
Output Low Voltage	V <sub>OL</sub>	I <sub>OUT</sub> = 10 mA		0.05	0.15		
Peak Output Current <sup>c</sup>	I <sub>SOURCE</sub>	V <sub>OUT</sub> = 0 V		-400	-200	mA	
	I <sub>SINK</sub>	V <sub>OUT</sub> = V <sub>CC</sub>	500	1000			

Notes

- a. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum.
- b. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- c. Guaranteed by design, not subject to production test.
- d. C<sub>STRAY</sub> ≤ 5 pF on C<sub>OSC</sub>.

**TYPICAL CHARACTERISTICS**



**TIMING WAVEFORMS**

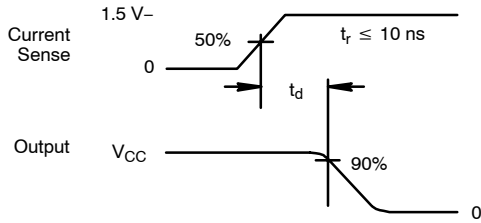


FIGURE 1.

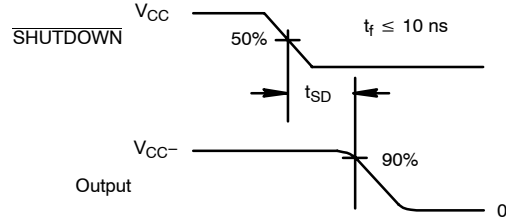
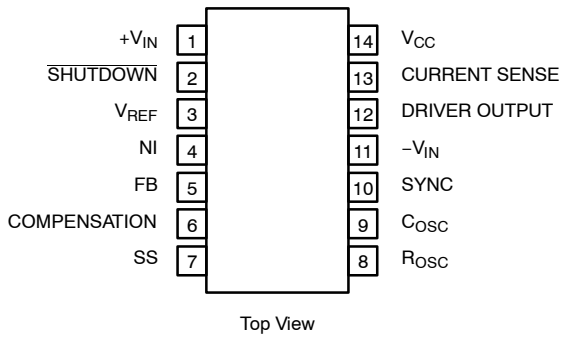


FIGURE 2.

**PIN CONFIGURATIONS AND ORDERING INFORMATION**

**Dual-In-Line and SOIC**



**ORDERING INFORMATION**

Part Number	Temperature Range	Package
Si9114ADY	-40 to 85°C	SOIC-14
Si9114ADY-T1		
Si9114ADY-T1—E3		
Si9114ADJ		PDIP-14
Si9114ADJ—E3		

**APPLICATIONS**

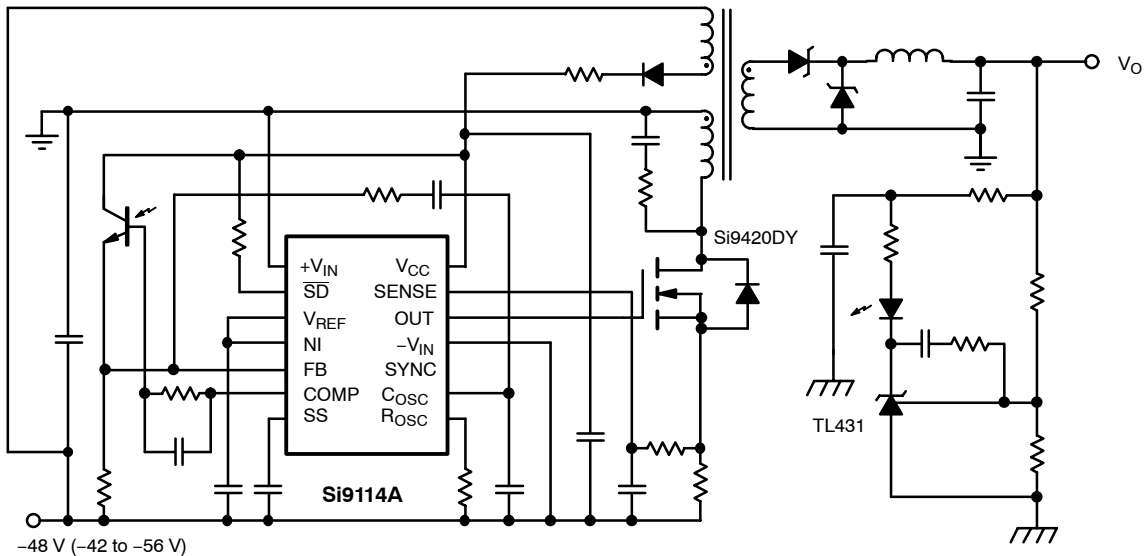
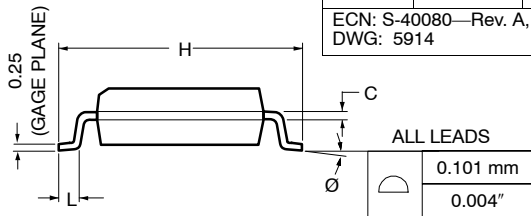
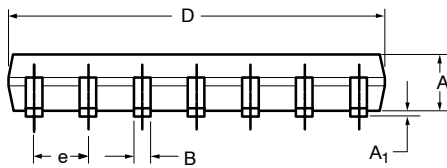
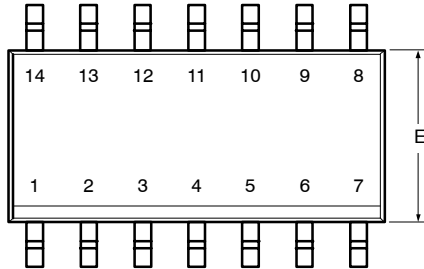


FIGURE 3. 15-W Forward Converter Schematic

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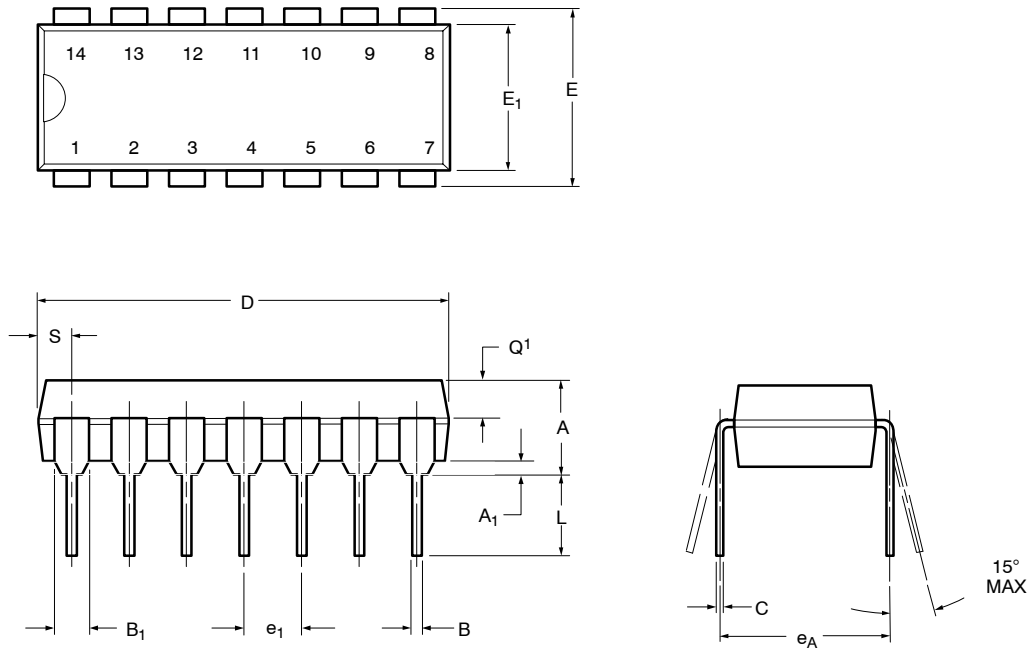
**SOIC (NARROW): 14-LEAD (POWER IC ONLY)**



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
<b>A</b>	1.35	1.75	0.053	0.069
<b>A<sub>1</sub></b>	0.10	0.20	0.004	0.008
<b>B</b>	0.38	0.51	0.015	0.020
<b>C</b>	0.18	0.23	0.007	0.009
<b>D</b>	8.55	8.75	0.336	0.344
<b>E</b>	3.8	4.00	0.149	0.157
<b>e</b>	1.27 BSC		0.050 BSC	
<b>H</b>	5.80	6.20	0.228	0.244
<b>L</b>	0.50	0.93	0.020	0.037
<b>Ø</b>	0°	8°	0°	8°

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DWG: 5914

**PDIP: 14-LEAD (POWER IC ONLY)**



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
<b>A</b>	3.81	5.08	0.150	0.200
<b>A<sub>1</sub></b>	0.38	1.27	0.015	0.050
<b>B</b>	0.38	0.51	0.015	0.020
<b>B<sub>1</sub></b>	0.89	1.65	0.035	0.065
<b>C</b>	0.20	0.30	0.008	0.012
<b>D</b>	17.27	19.30	0.680	0.760
<b>E</b>	7.62	8.26	0.300	0.325
<b>E<sub>1</sub></b>	5.59	7.11	0.220	0.280
<b>e<sub>1</sub></b>	2.29	2.79	0.090	0.110
<b>e<sub>A</sub></b>	7.37	7.87	0.290	0.310
<b>L</b>	2.79	3.81	0.110	0.150
<b>Q<sub>1</sub></b>	1.27	2.03	0.050	0.080
<b>S</b>	1.02	2.03	0.040	0.080

ECN: S-40081—Rev. A, 02-Feb-04  
DWG: 5919



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