High-Frequency Switchmode Controller

FEATURES

- 15- to 200-V Input Range
- Current-Mode Control
- Internal Start-Up Circuit
- Latched $\overline{\text{SHUTDOWN}}$
- Soft-Start
- 1.8-MHz Error Amp

DESCRIPTION

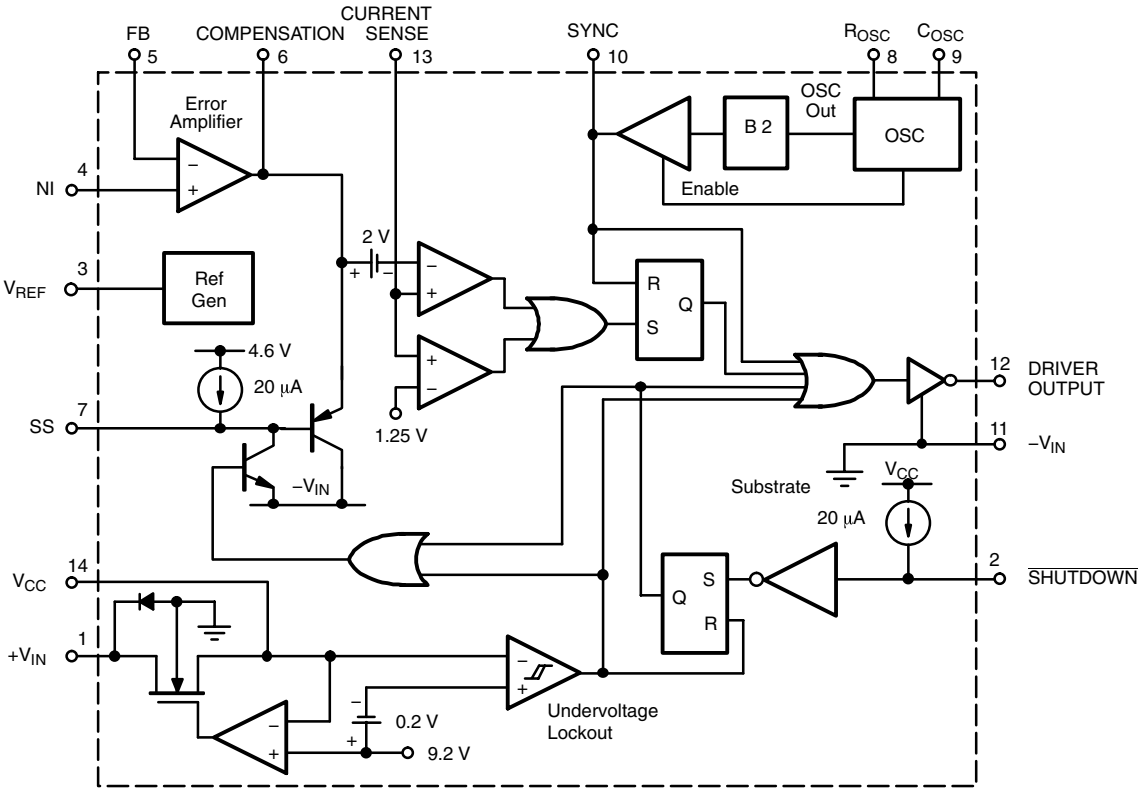
The Si9114A is a BiC/DMOS current-mode pulse width modulation (PWM) controller IC for high-frequency dc/dc converters. Single-ended topologies (forward and flyback) can be implemented at frequencies up to 1 MHz. The oscillator has an internal divide-by-two that limits the duty ratio to 50%. An oscillator 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 ($\overline{SHUTDOWN}$, 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 (Θ_{JA})
14-Pin Plastic Dip . . . . . 167°C/W
14-Pin SOIC . . . . . 140°C/W

Notes
a. Device mounted with all leads soldered or welded to PC board.
b. Derate 6 mW/°C above 25°C.
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 kΩ to 1 MΩ
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 Min[a]	Typ[b]	Max[a]	Unit
Reference						
Output Voltage	V_R	OSC Disabled, T_A = 25°C	3.94	4.0	4.06	V
		OSC Disabled Over Voltage and Temperature Ranges[c]	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
Oscillator						
Initial Accuracy	f_{OSC}[d]	R_{OSC} = 374 kΩ, C_{OSC} = 200 pF	90	100	110	kHz
		R_{OSC} = 70 kΩ, C_{OSC} = 200 pF	450	500	550	
Voltage Stability[c]	Δf/f	R_{OSC} = 70 kΩ, C_{OSC} = 200 pF Δf/f = [f(16.5 V) − f(9.5 V)] / f(9.5 V)		4	7	%
Temperature Coefficient[c]	OSC TC	−40 ≤ T_A ≤ 85°C, f_{OSC} = 100 kHz		200	500	ppm/°C
Sync Output Current (Master Mode)	$I_{SYNC(M)}$	$V_{ROSC} \le 5$ V	±1.0	±3.0		mA
Sync Output Current (Slave Mode)	$I_{SYNC(S)}$	$V_{ROSC} = V_{CC}$		±1	±500	nA
Error Amplifier (C_{OSC} = $-V_{IN}$ OSC Disabled)						
Input BIAS Current	I_{FB}	V_{FB} = 5 V, NI = V_{REF}		<1.0	±200	nA
Input OFFSET Voltage	V_{OS2}			±5	±25	mV
Open Loop Voltage Gain[c]	A_{VOL}		65	80		dB
Unity Gain Bandwidth[c]	BW		1.8	2.7		MHz
Output Current	I_{OUT}	Source (V_{FB} = 3.5 V, NI = V_{REF})		−2.7	−1.0	mA
		Sink (V_{FB} = 4.5 V, NI = V_{REF})	1.0	2.4		
Power Supply Rejection	PSRR	9.5 V ≤ V_{CC} ≤ 16.5 V	50	80		dB

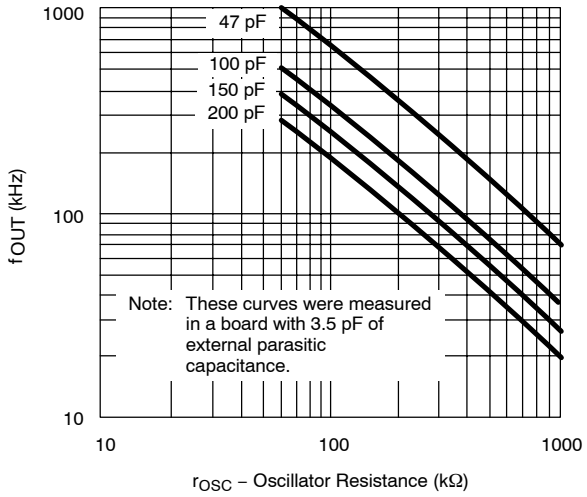
SPECIFICATIONS

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

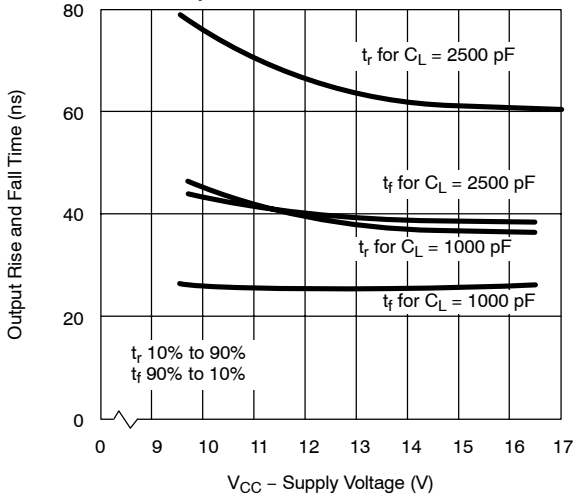
Notes
a. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum.
b. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
c. Guaranteed by design, not subject to production test.
d. $C_{STRAY} \leq$ 5 pF on C_{OSC}.

TYPICAL CHARACTERISTICS

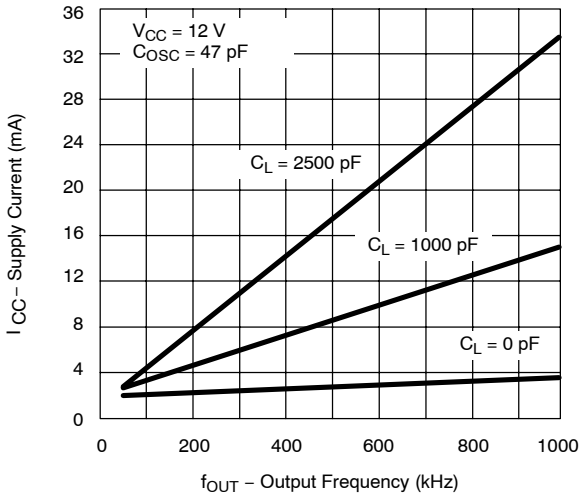
Oscillator Frequency



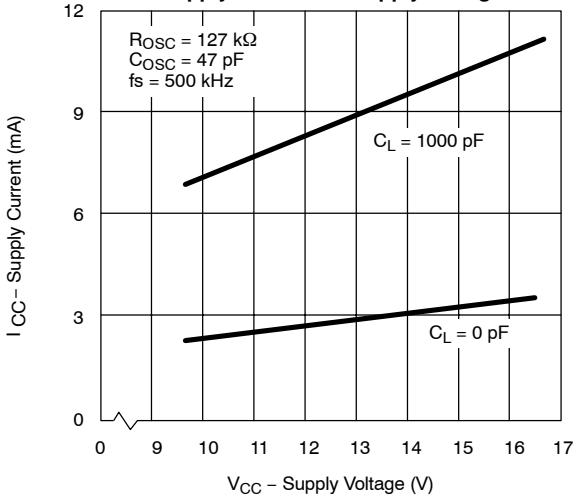
Output Driver Rise and Fall Time



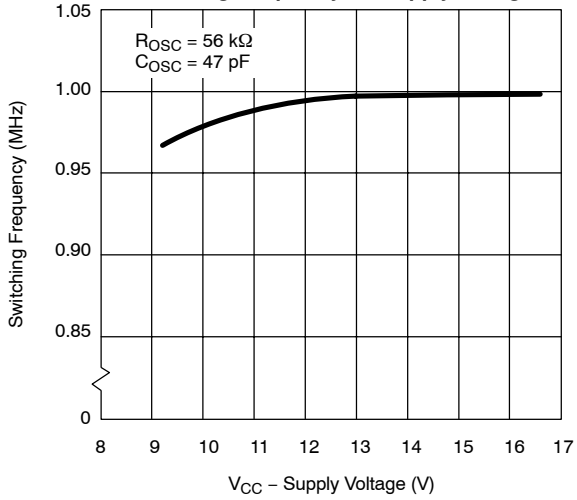
Supply Current vs. Output Frequency



Supply Current vs. Supply Voltage



Switching Frequency vs. Supply Voltage



TIMING WAVEFORMS

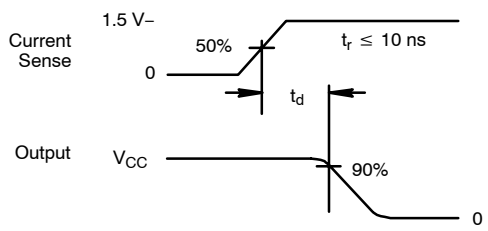


FIGURE 1.

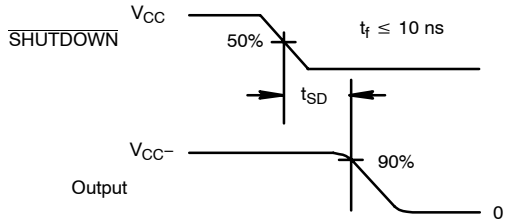
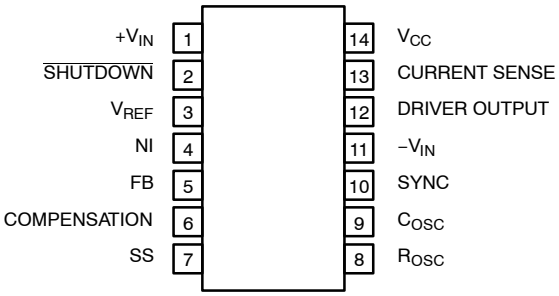


FIGURE 2.

PIN CONFIGURATIONS AND ORDERING INFORMATION

Dual-In-Line and SOIC



Top View

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

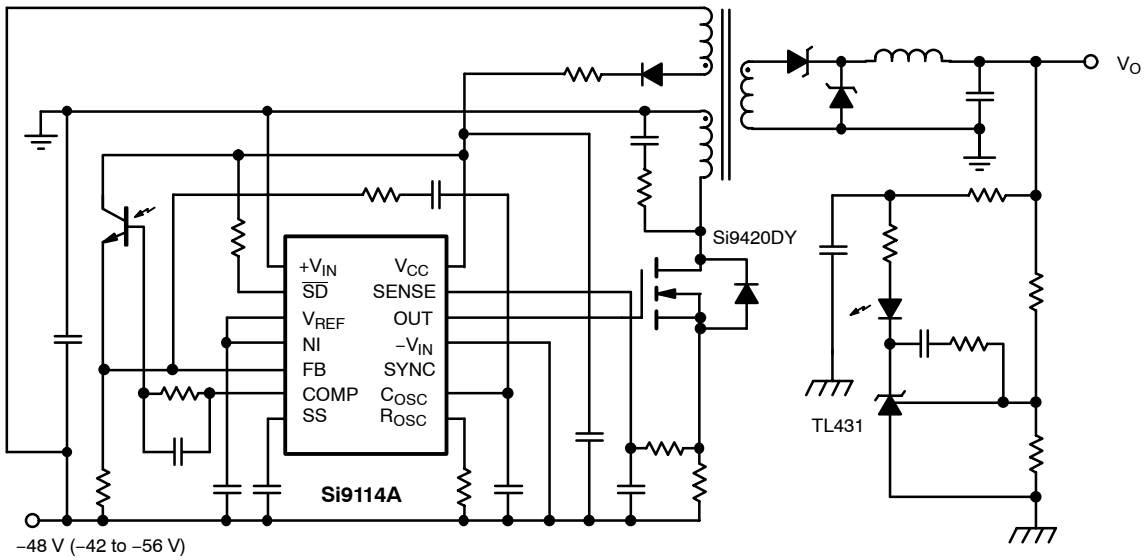


FIGURE 3. 15-W Forward Converter Schematic

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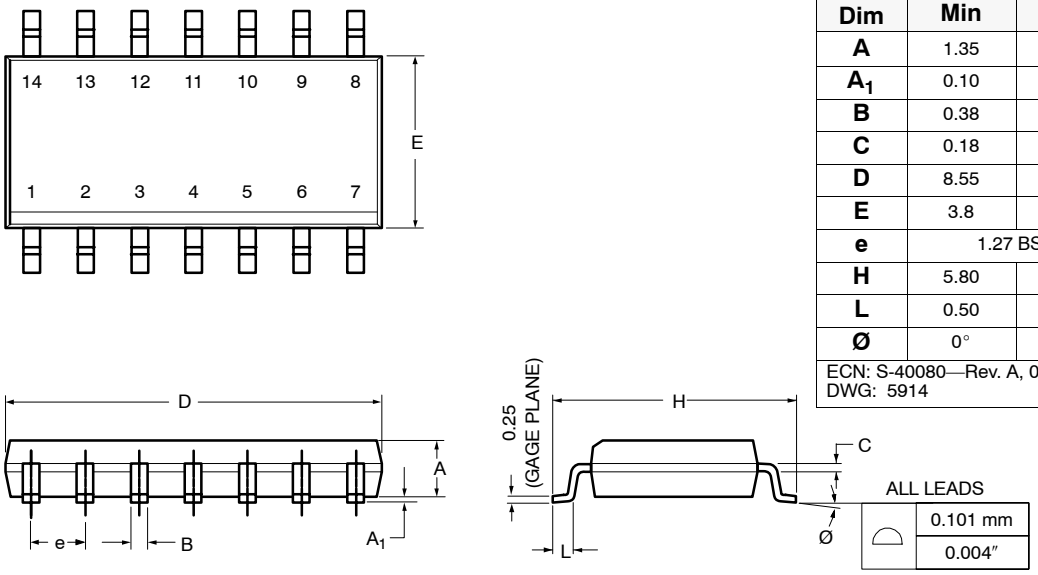
SOIC (NARROW): 14-LEAD (POWER IC ONLY)



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A_1	0.10	0.20	0.004	0.008
B	0.38	0.51	0.015	0.020
C	0.18	0.23	0.007	0.009
D	8.55	8.75	0.336	0.344
E	3.8	4.00	0.149	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
L	0.50	0.93	0.020	0.037
Ø	0°	8°	0°	8°

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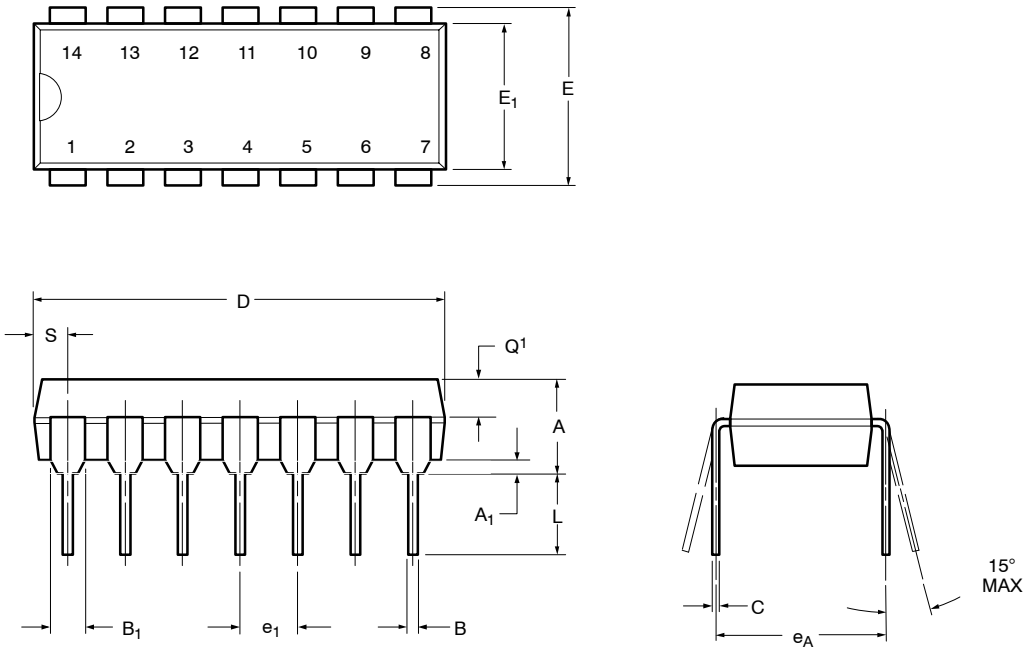
DWG: 5914

PDIP: 14-LEAD (POWER IC ONLY)



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	3.81	5.08	0.150	0.200
A_1	0.38	1.27	0.015	0.050
B	0.38	0.51	0.015	0.020
B_1	0.89	1.65	0.035	0.065
C	0.20	0.30	0.008	0.012
D	17.27	19.30	0.680	0.760
E	7.62	8.26	0.300	0.325
E_1	5.59	7.11	0.220	0.280
e_1	2.29	2.79	0.090	0.110
e_A	7.37	7.87	0.290	0.310
L	2.79	3.81	0.110	0.150
Q_1	1.27	2.03	0.050	0.080
S	1.02	2.03	0.040	0.080
ECN: S-40081—Rev. A, 02-Feb-04 DWG: 5919				

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