



**THE DATASHEET OF  
SG1845J-DESC**



# Current Mode PWM Controller

## Description

The SG1844/45 family of control ICs provides all the required features to implement off-line Fixed Frequency, Current-mode switching power supplies with a minimum number of external components. Current-mode architecture demonstrates improved line regulation, improved load regulation, pulse-by-pulse current limiting and inherent protection of the power supply output switch.

The Bandgap reference is trimmed to  $\pm 1\%$  over temperature. Oscillator discharge current is trimmed to less than  $\pm 10\%$ . The SG1844/45 has under-voltage lockout, current-limiting circuitry and start-up current of less than 1mA. The totem-pole output is optimized to drive the gate of a power MOSFET. The output is low in the off state to provide direct interface to an N-channel device. Both operate up to a maximum duty cycle range of zero to  $<50\%$  due to an internal toggle flip-flop which blanks the output off every other clock cycle. The SG1844/45 is specified for operation over the full military ambient temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SG3844/45 is designed for the commercial range of  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

## Features

- Optimized for Off-Line Control
- Low Start-Up Current ( $<1\text{mA}$ )
- Automatic Feed Forward Compensation
- Trimmed Oscillator
- Discharge Current
- Pulse-By-Pulse Current Limiting
- Enhanced Load Response Characteristics
- Undervoltage Lockout with 6V Hysteresis (SG1844 only)
- Double Pulse Suppression
- High-Current Totem-Pole Output
- Internally Trimmed Bandgap Reference
- 500kHz Operation
- Under-voltage Lockout
- SG1844 - 16 Volts
- SG1845 - 8.4 Volts
- Low Shoot-through Current  $<75\text{mA}$  Over Temperature

## Application

- Available to MIL-STD-883
- Available to DSCC
  - Standard Microcircuit Drawing (SMD)
- SGR1844/45 Rad-Tolerant Version Available

## Product Highlight

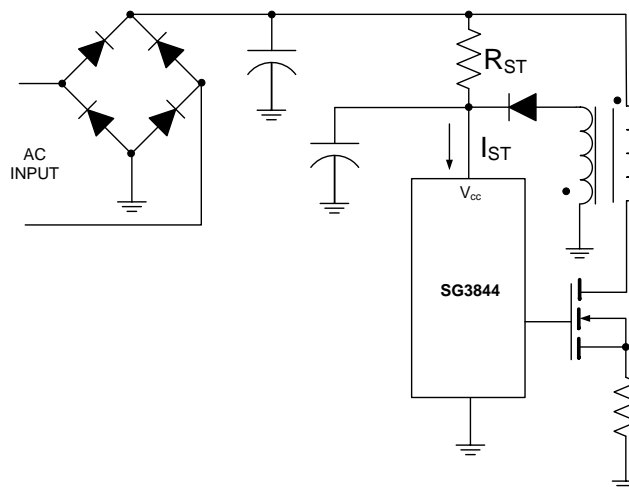
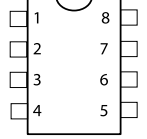
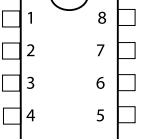
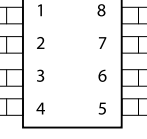
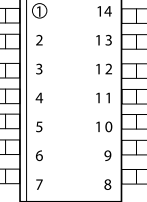


Figure 1 - Product Highlight

## Connection Diagrams and Ordering Information

Ambient Temperature	Type	Package	Part Number	Packaging Type	Connection Diagram
0°C to 70°C	M	8-PIN PLASTIC DUAL INLINE PACKAGE	SG3844M	PDIP	 <p><b>M PACKAGE</b> (Top View)</p> <p>M Package: RoHS / Pb-free 100% Matte Tin Lead Finish</p>
			SG3845M		
-55°C to 125°C	Y	8-PIN CERAMIC DUAL INLINE PACKAGE	SG1844Y	CERDIP	 <p><b>Y PACKAGE</b> (Top View)</p> <p>PbSn Tin Lead Finish</p>
			SG1845Y		
			SG1844Y-883B		
			SG1845Y-883B		
			SG1844Y-DESC		
			SG1845Y-DESC		
0°C to 70°C	DM	8-PIN SMALL OUTLINE INTEGRATED CIRCUIT	SG3844DM	SOIC	 <p><b>DM PACKAGE</b> (Top View)</p> <p>RoHS / Pb-free 100% Matte Tin Lead Finish</p>
			SG3845DM		
0°C to 70°C	D	14-PIN SMALL OUTLINE INTEGRATED CIRCUIT	SG3844D	SOIC	 <p><b>D PACKAGE</b> (Top View)</p> <p>RoHS / Pb-free 100% Matte Tin Lead Finish</p>
			SG3845D		

Ambient Temperature		Package	Part Number	Packaging Type	Connection Diagram
-55°C to 125°C	J	14-PIN CERAMIC DUAL INLINE PACKAGE	SG1844J	CERDIP	<p><b>J PACKAGE</b> (Top View) PbSn Lead Finish</p>
			SG1845J		
			SG1844J-883B		
			SG1845J-883B		
			SG1844J-DESC		
			SG1845J-DESC		
-55°C to 125°C	F	10-PIN CERAMIC FLAT PACK PACKAGE	SG1844F-DESC	FLAT PACK	<p><b>F PACKAGE</b> (Top View) PbSn Lead Finish</p>
			SG1845F-DESC		
-55°C to 125°C	L	20-Pin CERAMIC	SG1844L	Ceramic (LCC) Leadless Chip Carrier	<p><b>L PACKAGE</b> (Top View) PbSn Lead Finish</p>
			SG1845L		
			SG1844L-883B		
			SG1845L-883B		
			SG1844L-DESC		
			SG1845L-DESC		

**Notes:**

- Contact factory for DESC part availability.
- All parts are viewed from the top.
- Available in Tape & Reel. Append the letters "TR" to the part number. (i.e. SG3844D-TR)
- Hermetic Packages J, F, L, & Y use Pb37/Sn63 hot solder lead finish, contact factory for availability of RoHS versions.

## Absolute Maximum Ratings<sup>1 - 2</sup>

Parameter	Value	Units
Supply Voltage (Low Impedance Source)	30	V
Output Current (Peak)	±1	A
Output Current (Continuous)	350	mA
Output Energy (Capacitive Load)	5	μJ
Analog Inputs ( $V_{FB}$ , $I_{SENSE}$ )	-0.3 to +6.3	V
Error Amplifier Output Sink Current	10	mA
<b>Operating Junction Temperature</b>		
Hermetic (J, Y, F, L Packages)	150	°C
Plastic (M, D, DM Packages)	150	°C
Storage Temperature Range	-65 to +150	°C
Lead Temperature (Soldering, 10 Seconds)	300	°C
RoHS / Pb-free Peak Package Solder Reflow Temp. (40 second max. exposure)	260 (+0, -5)	°C
<i>Notes:</i>		
1. Exceeding these ratings could cause damage to the device.		
2. All voltages are with respect to Pin 5. All currents are positive into the specified terminal.		

## Thermal Data

Parameter	Value	Units
<b>M Package:</b>		
Thermal Resistance-Junction to Ambient, $\theta_{JA}$	95	°C/W
<b>DM Package:</b>		
Thermal Resistance-Junction to Ambient, $\theta_{JA}$	165	°C/W
<b>D Package:</b>		
Thermal Resistance-Junction to Ambient, $\theta_{JA}$	120	°C/W
<b>Y Package:</b>		
Thermal Resistance-Junction to Case, $\theta_{JC}$	30	°C/W
Thermal Resistance-Junction to Ambient, $\theta_{JA}$	130	°C/W
<b>J Package</b>		
Thermal Resistance-Junction to Case, $\theta_{JC}$	30	°C/W
Thermal Resistance-Junction to Ambient, $\theta_{JA}$	80	°C/W
<b>F Package</b>		
Thermal Resistance-Junction to Case, $\theta_{JC}$	80	°C/W
Thermal Resistance-Junction to Ambient, $\theta_{JA}$	145	°C/W
<b>L Package</b>		
Thermal Resistance-Junction to Case, $\theta_{JC}$	35	°C/W
Thermal Resistance-Junction to Ambient, $\theta_{JA}$	120	°C/W
<i>Notes:</i>		
Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$ .		
The $\theta_{JA}$ numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.		

## Recommended Operating Conditions<sup>3</sup>

Symbol	Parameter	Recommended Operating Conditions			Units
		Min.	Typ.	Max.	
V <sub>S</sub>	Supply Voltage Range		30		V
I <sub>PK</sub>	Output Current (Peak)		±1		A
I <sub>OUT</sub>	Output Current (Continuous)		200		mA
	Analog Inputs (Pin 2, Pin 3)	0		2.6	V
E <sub>AISNK</sub>	Error Amp Output Sink Current		5		mA
OSC <sub>FR</sub>	Oscillator Frequency Range	0.1		500	kHz
R <sub>T</sub>	Oscillator Timing Resistor	0.52		150	kΩ
C <sub>T</sub>	Oscillator Timing Capacitor	0.001		1.0	μF
Operating Ambient Temperature Range:					
	SG1844/45	-55		125	°C
	SG3844/45	0		70	°C

*Note:*  
3. Range over which the device is functional.

## Electrical Characteristics

Unless otherwise specified, these specifications apply over the operating ambient temperatures for SG1844/SG1845 with  $-55^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$ , SG3844/SG3845 with  $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ , V<sub>CC</sub> = 15V (Note 7), R<sub>T</sub> = 10kΩ, and C<sub>T</sub> = 3.3nF. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.

Symbol	Parameter	Test Conditions	SG1844/SG1845			SG3844/SG3845			Units
			Min.	Typ.	Max	Min.	Typ.	Max	
<b>Reference Section</b>									
V <sub>REF</sub>	Output Voltage	T <sub>J</sub> = 25°C, I <sub>O</sub> = 1mA	4.95	5.00	5.05	4.90	5.00	5.10	V
V <sub>REG</sub>	Line Regulation	12V ≤ V <sub>IN</sub> ≤ 25V		6	20		6	20	mV
I <sub>REG</sub>	Load Regulation	1 ≤ I <sub>O</sub> ≤ 20mA		6	25		6	25	mV
	Temperature Stability <sup>4</sup>			0.2	0.4		0.2	0.4	mV/°C
	Total Output Variation <sup>4</sup>	Line, Load, Temperature	4.90		5.10	4.82		5.18	V
V <sub>N</sub>	Output Noise Voltage <sup>4</sup>	10Hz ≤ f ≤ 10kHz, T <sub>J</sub> = 25°C		50			50		μV
	Long Term Stability <sup>4</sup>	T <sub>A</sub> = 125°C, 1000hrs		5	25		5	25	mV
V <sub>REFISC</sub>	Output Short Circuit		-30	-100	-180	-30	-100	-180	mA
<b>Oscillator Section</b>									
f	Initial Accuracy <sup>8</sup>	T <sub>J</sub> = 25°C	47	52	57	47	52	57	kHz
f <sub>REG</sub>	Voltage Stability	12V ≤ V <sub>CC</sub> ≤ 25V		.02	1		0.2	1	%
	Temperature Stability <sup>4</sup>	T <sub>MIN</sub> ≤ T <sub>A</sub> ≤ T <sub>MAX</sub>		5			5		%
OSC <sub>PP</sub>	Amplitude	V <sub>RT/CT</sub> (Peak to Peak)		1.7			1.7		V
I <sub>DSG</sub>	Discharge Current	T <sub>J</sub> = 25°C	7.8	8.3	9.1	7.5	8.4	9.3	mA
		T <sub>MIN</sub> ≤ T <sub>A</sub> ≤ T <sub>MAX</sub>	6.8		9.3	7.2		9.5	mA

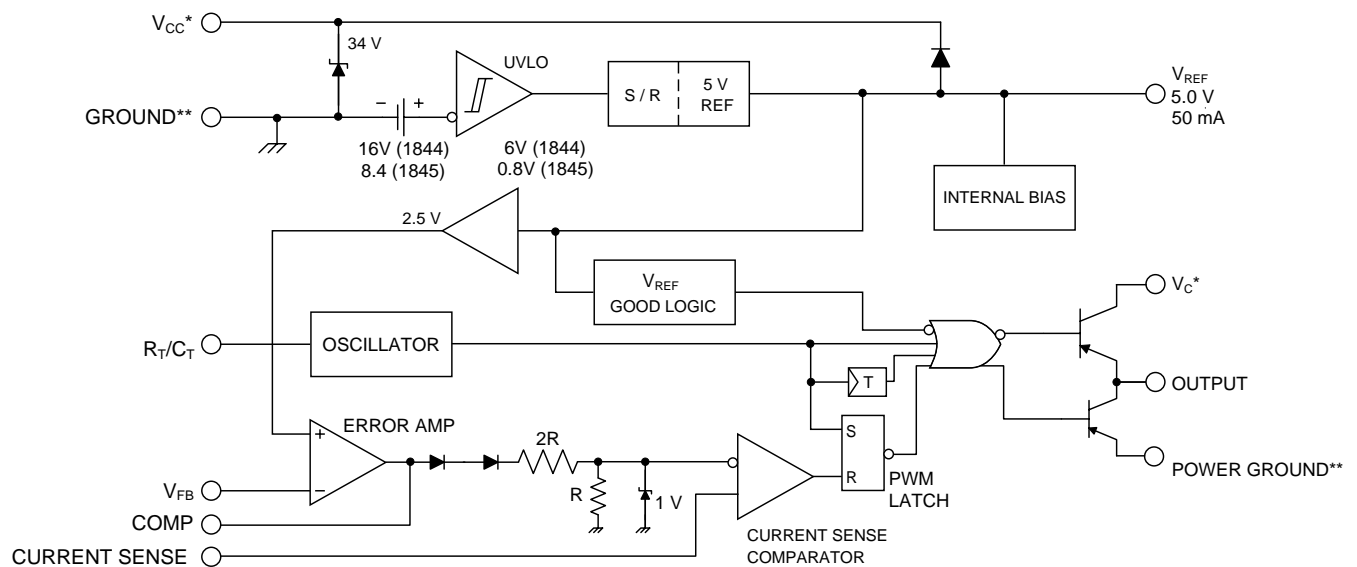
Symbol	Parameter	Test Conditions	SG1844/SG1845			SG3844/SG3845			Units
			Min.	Typ.	Max	Min.	Typ.	Max	
<b>Error Amplifier Section</b>									
EA <sub>IH</sub>	Input Voltage	V <sub>COMP</sub> = 2.5V	2.45	2.50	2.55	2.42	2.50	2.58	V
EA <sub>IIB</sub>	Input Bias Current			-0.3	-1		-0.3	-2	μA
A <sub>VOL</sub>	Open Loop Gain	2V ≤ V <sub>O</sub> ≤ 4V	65	90		65	90		dB
EA <sub>BW</sub>	Unity Gain Bandwidth <sup>4</sup>	T <sub>J</sub> = 25°C	0.7	1		0.7	1		MHz
PSRR	Power Supply Rejection Ratio	12V ≤ V <sub>CC</sub> ≤ 25V	60	70		60	70		dB
EA <sub>SNK</sub>	Output Sink Current	V <sub>VFB</sub> = 2.7V, V <sub>COMP</sub> = 1.1V	2	6		2	6		mA
EA <sub>SRC</sub>	Output Source Current	V <sub>VFB</sub> = 2.3V, V <sub>COMP</sub> = 5V	-0.5	-0.8		-0.5	-0.8		mA
EA <sub>VOH</sub>	V <sub>OUT</sub> High	V <sub>VFB</sub> = 2.3V, R <sub>L</sub> = 15k to GND	5	6		5	6		V
EA <sub>VOL</sub>	V <sub>OUT</sub> Low	V <sub>VFB</sub> = 2.7V, R <sub>L</sub> = 15k to V <sub>REF</sub>		0.7	1.1		0.7	1.1	V
<b>Current Sense Section</b>									
CS <sub>AVOL</sub>	Gain <sup>5 &amp; 6</sup>		2.85	3	3.15	2.85	3	3.15	V/V
	Maximum Input Signal <sup>5</sup>	V <sub>COMP</sub> = 5V	0.9	1	1.1	0.9	1	1.1	V
PSRR	Power Supply Rejection Ratio	12V ≤ V <sub>CC</sub> ≤ 25V		70			70		dB
CS <sub>IIB</sub>	Input Bias Current			-2	-10		-2	-10	μA
CS <sub>DELAY</sub>	Delay to Output <sup>4</sup>			150	300		150	300	ns
<b>Output Section</b>									
VOL	Output Low Level	I <sub>SINK</sub> = 20mA		0.1	0.4		0.1	0.4	V
		I <sub>SINK</sub> = 200mA		1.5	2.2		1.5	2.2	V
VOH	Output High Level	I <sub>SOURCE</sub> = 200mA	13	13.5		13	13.5		V
		I <sub>SOURCE</sub> = 200mA	12	13.5		12	13.5		V
RS	Rise Time <sup>4</sup>	T <sub>J</sub> = 25°C, C <sub>L</sub> = 1nF		50	150		50	150	ns
FT	Fall Time <sup>4</sup>	T <sub>J</sub> = 25°C, C <sub>L</sub> = 1nF		50	150		50	150	ns
<b>Under-Voltage Lockout Section</b>									
UVLO	Start Threshold	1844	15	16	17	14.5	16	17.5	V
		1845	7.8	8.4	9.0	7.8	8.4	9.0	V
V <sub>S</sub> MIN	Min. Operation Voltage After Turn-On	1844	9	10	11	8.5	10	11.5	V
		1845	7.0	7.6	8.3	7.0	7.6	8.2	V
<b>PWM Section</b>									
DC <sub>MAX</sub>	Maximum Duty Cycle		46	48	50	46	48	50	%
DC <sub>MIN</sub>	Minimum Duty Cycle				0			0	%
<b>Power Consumption Section</b>									

Symbol	Parameter	Test Conditions	SG1844/SG1845			SG3844/SG3845			Units
			Min.	Typ.	Max	Min.	Typ.	Max	
I <sub>s</sub>	Start-Up Current			0.5	1		0.5	1	mA
I	Operating Supply Current	V <sub>F<sub>FB</sub></sub> = V <sub>I<sub>SENSE</sub></sub> = 0V		11	17		11	17	mA
Z	V <sub>CC</sub> Zener Voltage	I <sub>CC</sub> = 25mA		34			34		V

*Note:*

- These parameters, although guaranteed, are not 100% tested in production.
- Parameter measured at trip point of latch with V<sub>F<sub>FB</sub></sub> = 0.
- Gain defined as:  $A = \Delta V_{COMP} / \Delta V_{I_{SENSE}}$ ;  $0 \leq V_{I_{SENSE}} \leq 0.8V$
- Adjust V<sub>CC</sub> above the start threshold before setting at 15V.
- Output frequency equals one half of oscillator frequency.

## Block Diagram

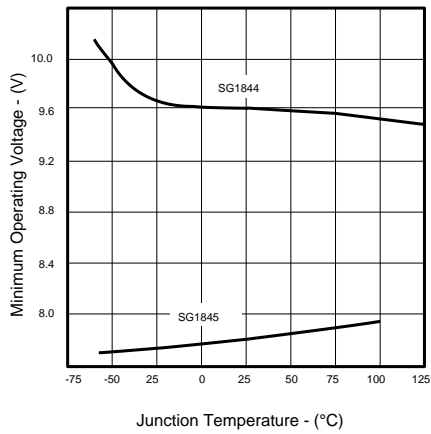


\* - V<sub>CC</sub> and V<sub>C</sub> are internally connected for 8-pin packages.

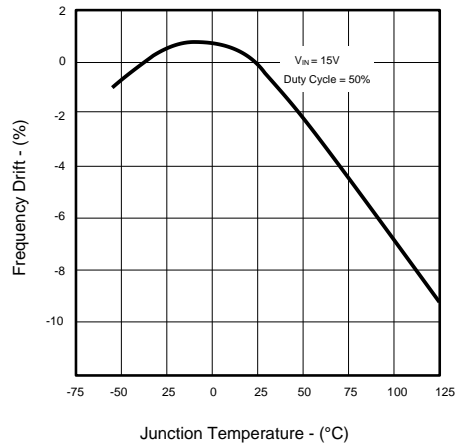
\*\* - POWER GROUND and GROUND are internally connected for 8-pin packages.

**Figure 2 - Block Diagram**

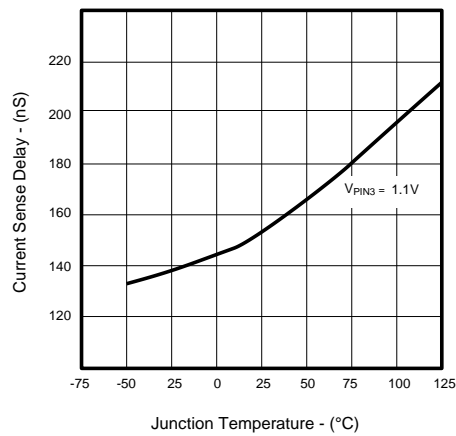
## Characteristic Curves



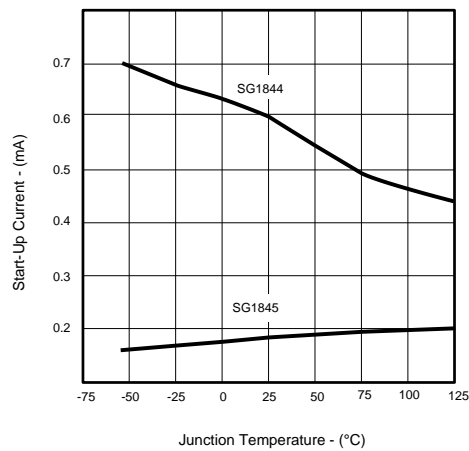
**Figure 3** - Drop-out Voltage vs. Temperature



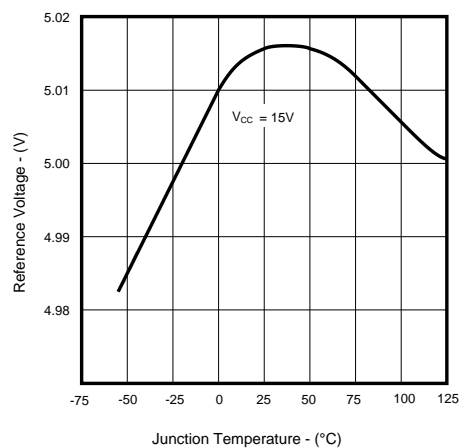
**Figure 4** - Oscillator Temperature Stability



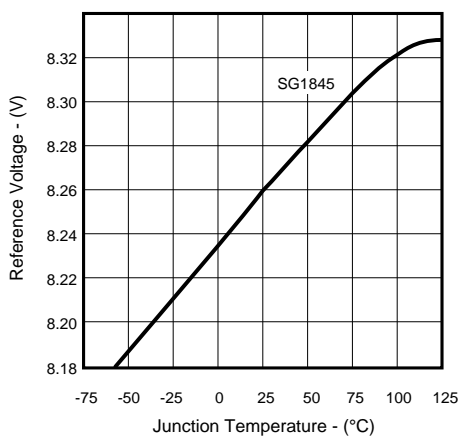
**Figure 5** - Current Sense to Output Delay vs. Temperature



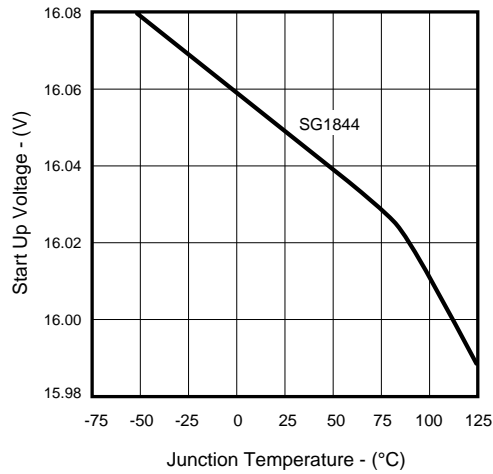
**Figure 6** - Start-Up Current vs. Temperature



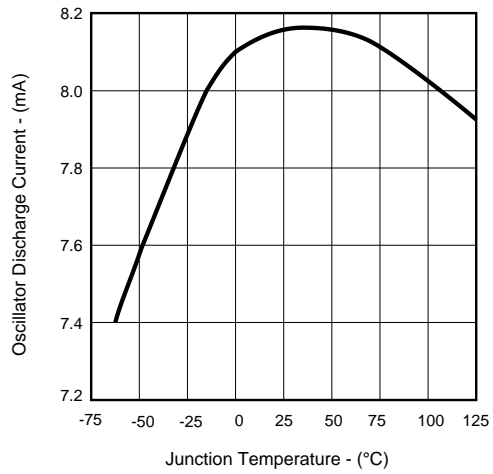
**Figure 7** - Reference Voltage vs. Temperature



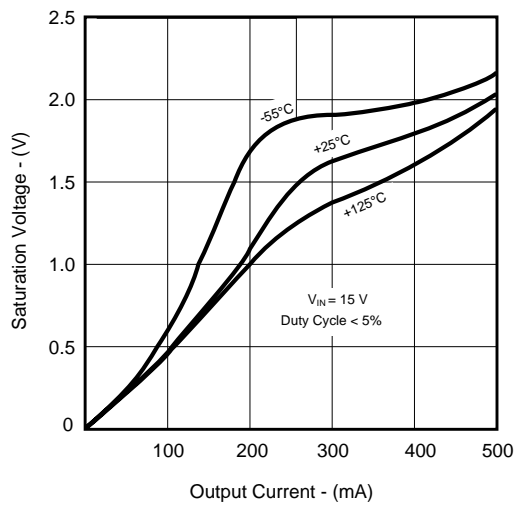
**Figure 8** - Start-Up Voltage Threshold vs. Temperature



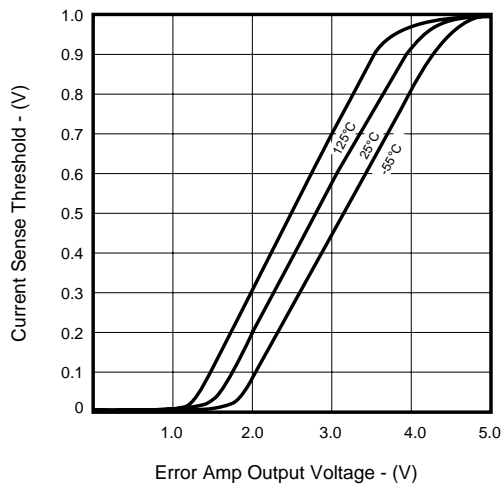
**Figure 9** - Start-Up Voltage Threshold vs. Temperature



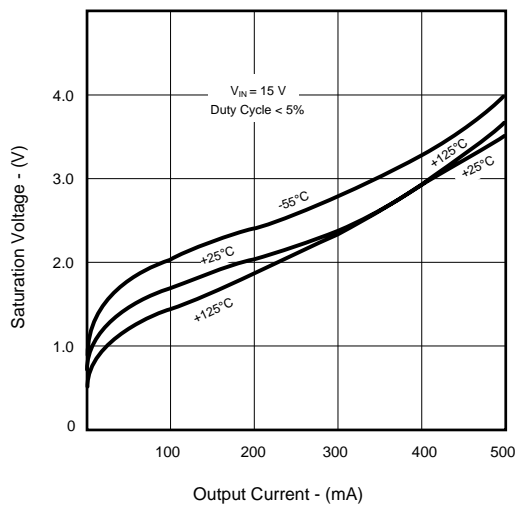
**Figure 10** - Oscillator Discharge Current vs. Temperature



**Figure 11** - Output Saturation Voltage vs. Output Current and Temperature (Sink Transistor)



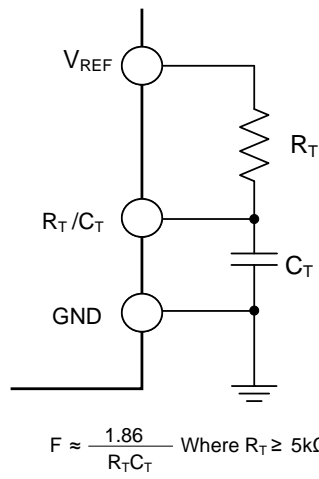
**Figure 12** - Current Sense Threshold vs. Error Amplifier Output



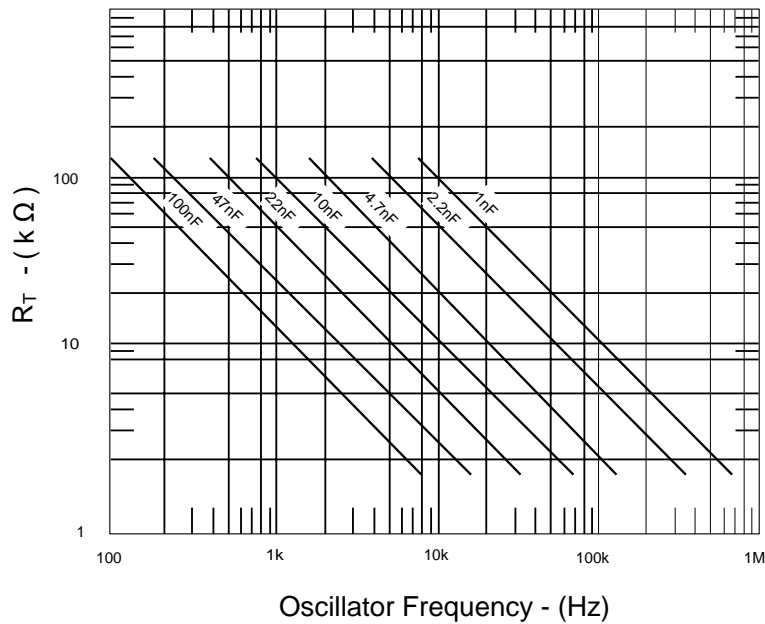
**Figure 13** - Output Saturation Voltage vs. Output Current and Temperature (Source Transistor)

## Application Information

The oscillator of the 1844/45 family of PWM's is programmed by the external timing components ( $R_T$ ,  $C_T$ ) as shown in Figure 14.



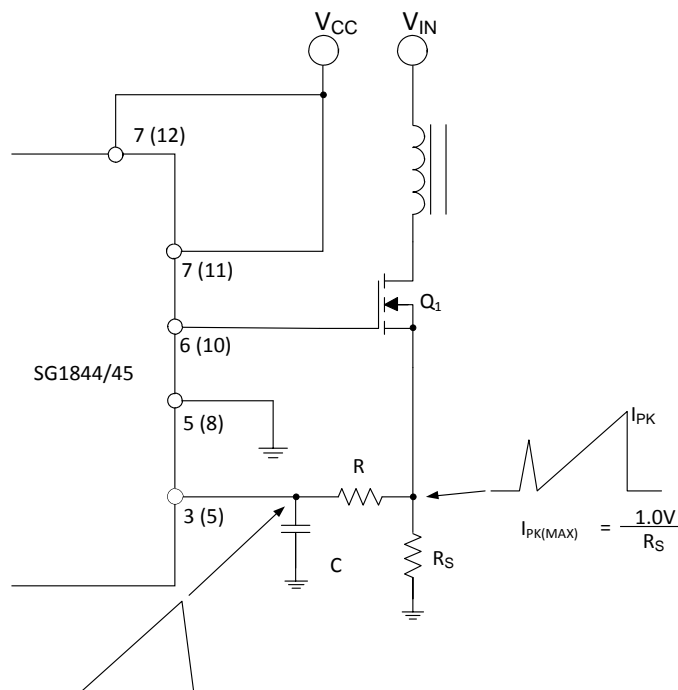
**Figure 14** - Oscillator Timing Circuit



**Figure 15** - Oscillator Frequency vs.  $R_T$  for various  $C_T$

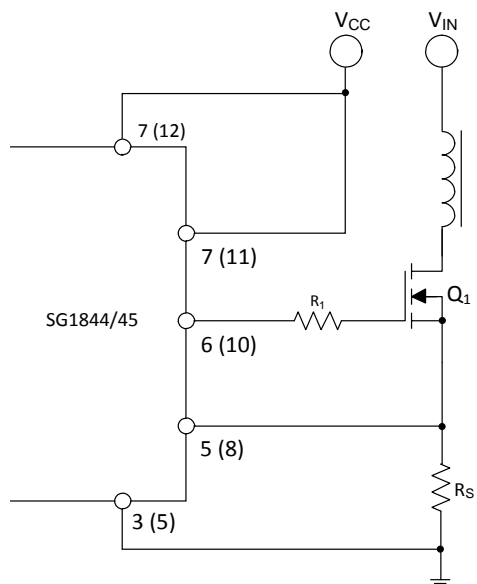
## Typical Application Circuits

Pin numbers referenced are for 8-pin package and pin numbers in parenthesis are for 14-pin package.



**Figure 16** • Current Sense Spike Suppression

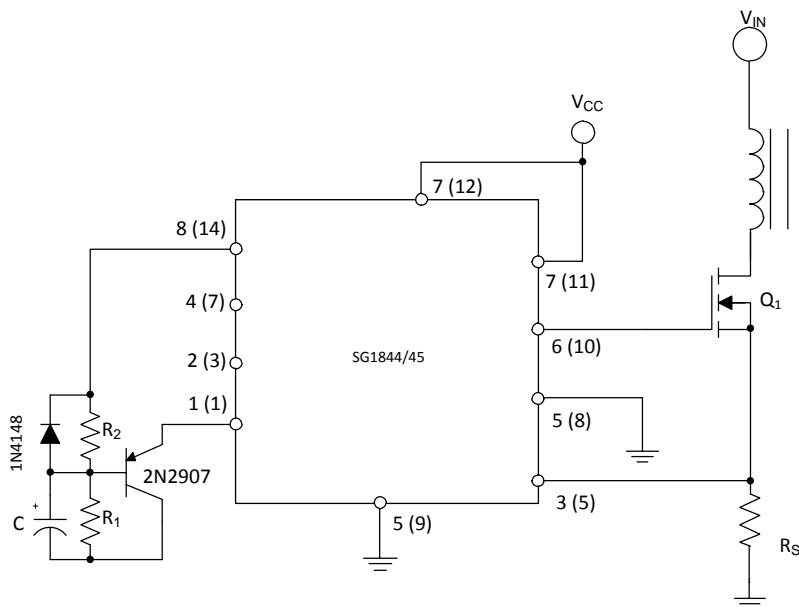
The RC low-pass filter will eliminate the leading edge current spike caused by parasitic of Power MOSFET.



**Figure 17** • MOSFET Parasitic Oscillations

A resistor (R1) in series with the MOSFET gate reduce overshoot and ringing caused by the MOSFET input capacitance and any inductance in series with the gate drive. (Note: It is very important to have a low inductance ground path to insure correct operation of the I.C. This can be done by making the ground paths as short and as wide as possible.)





$$I_{PK} = \frac{V_1}{R_5} \quad \text{Where, } 0 \leq V_1 \leq 1.0 \text{ V}$$

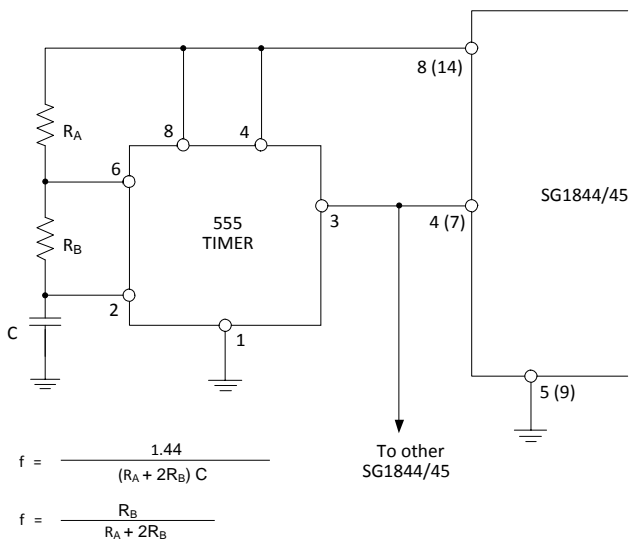
$$\text{and } V_1 = \frac{1.43 - 0.23 \frac{R_1}{R_2}}{1 + \frac{R_1}{R_2}}$$

$$t_{SOFTSTART} = -\ln\left[\frac{V_C}{R_2}\right] C \frac{R_1 R_2}{R_2 + R_2}$$

$$\text{Where, } V_2 = \frac{0.05}{1 + \frac{R_1}{R_2}}$$

**Figure 20** • Adjustable Buffered Reduction of Clamp Level with Softstart

Softstart and adjustable peak current can be done with the external circuitry shown above.

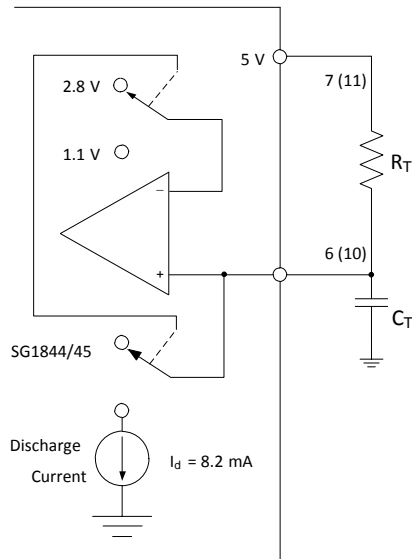


$$f = \frac{1.44}{(R_A + 2R_B) C}$$

$$f = \frac{R_B}{R_A + 2R_B}$$

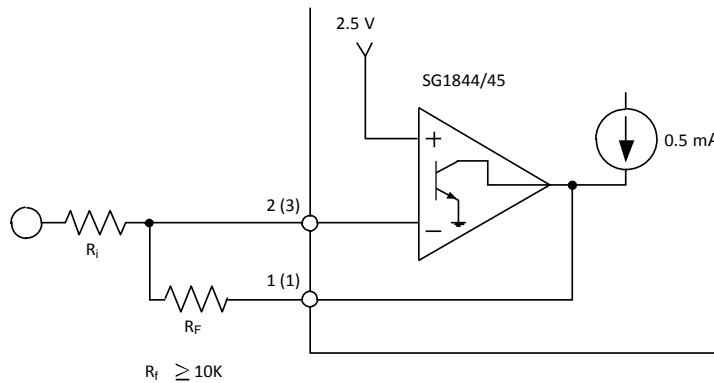
**Figure 21** • External Duty Cycle Clamp and Multi-Unit Synchronization

Precision duty cycle limiting for a duty cycle of <50%, as well as synchronizing several 1844/45's is possible with the above circuitry.



**Figure 22** · Oscillator Connection

The oscillator is programmed by the values selected for the timing components  $R_T$  and  $C_T$ . Refer to application information for calculation of the component values.

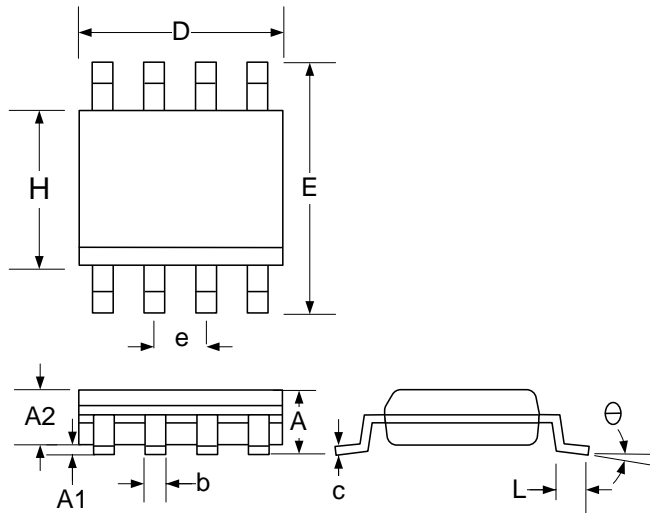


**Figure 23** · Error Amplifier Connection

Error amplifier is capable of sourcing and sinking current up to 0.5mA.

## PACKAGE OUTLINE DIMENSIONS

Controlling dimensions are in inches, metric equivalents are shown for general information.



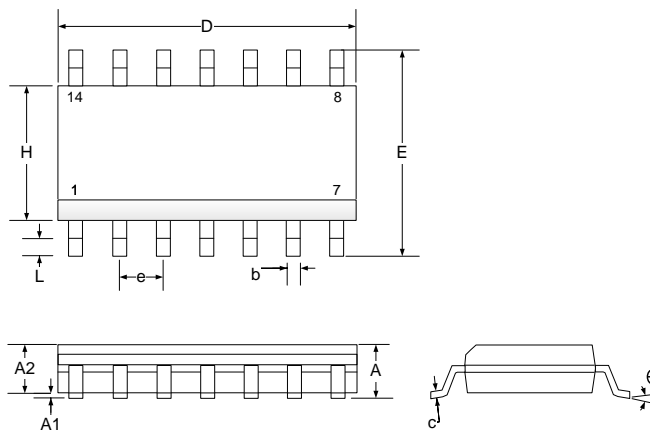
Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.52	0.049	0.060
b	0.33	0.51	0.013	0.020
c	0.19	0.25	0.007	0.010
D	4.83	5.21	0.189	0.205
E	5.79	6.20	0.228	0.244
e	1.27 BSC		0.050 BSC	
H	3.81	4.01	0.150	0.158
L	0.40	1.27	0.016	0.050
θ	0	8	0	8
*LC		.010		0.004

\*Lead Coplanarity

**Note:**

- Dimensions do not include mold flash or protrusions; these shall not exceed 0.155mm (.006") on any side. Lead dimension shall not include solder coverage

**Figure 24 • DM 8-Pin SOIC Package Dimensions**



Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.52	0.049	0.060
b	0.33	0.51	0.013	0.020
c	0.19	0.25	0.007	0.010
D	8.54	8.74	0.336	0.344
E	5.79	6.20	0.228	0.244
e	1.27 BSC		0.050 BSC	
H	3.81	4.01	0.150	0.158
L	0.40	1.27	0.016	0.050
θ	0	8	0	8
*LC		.010		0.004

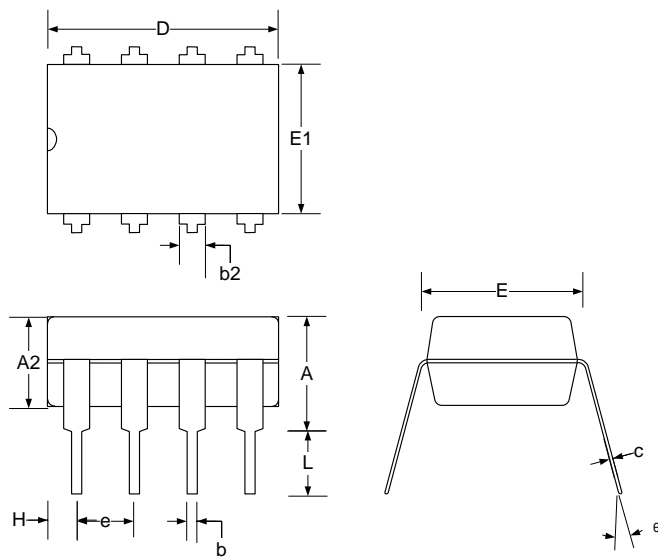
\*Lead Coplanarity

**Note:**

- Dimensions do not include mold flash or protrusions; these shall not exceed 0.155mm (.006") on any side. Lead dimension shall not include solder coverage

**Figure 25 • D 14-Pin SOIC Package Dimensions**

## PACKAGE OUTLINE DIMENSIONS



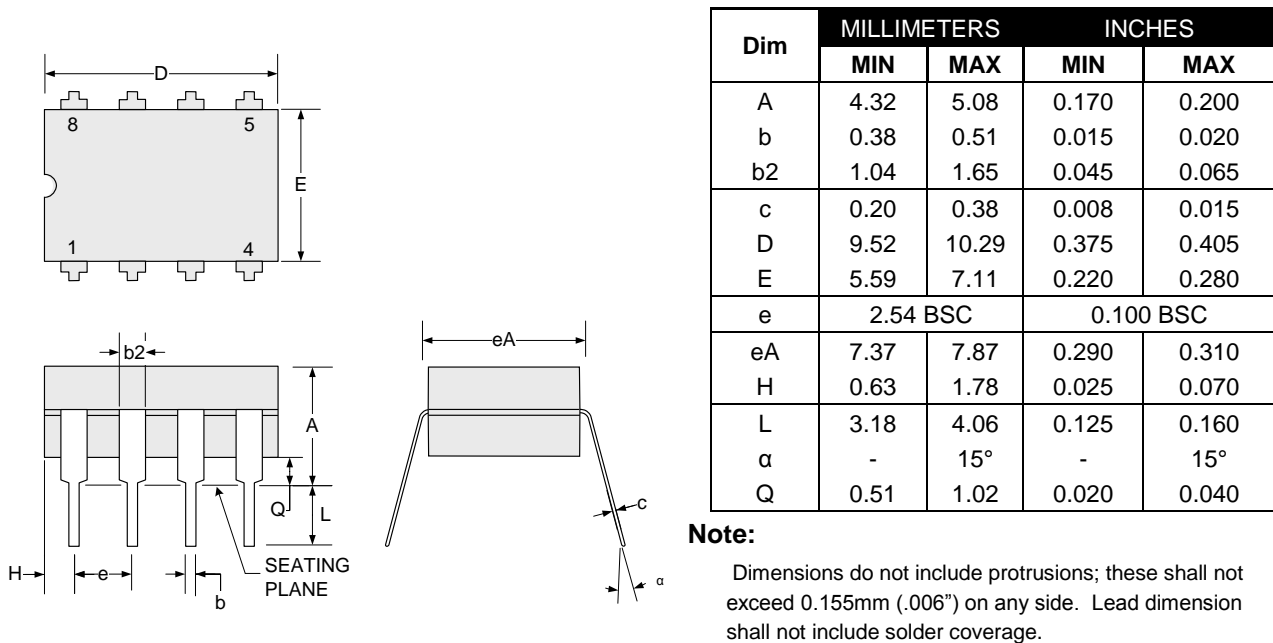
Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A		5.08		0.200
A2	3.30 Typ.		1.30 Typ.	
b	0.38	0.51	0.145	0.020
b2	0.76	1.65	0.030	0.065
c	0.20	0.38	0.008	0.015
D		10.16		0.400
E	7.62 BSC		0.300 BSC	
e	2.54 BSC		0.100 BSC	
E1	6.10	6.86	0.240	0.270
L	3.05		0.120	
$\theta$	0	15	0	15

**Note:**

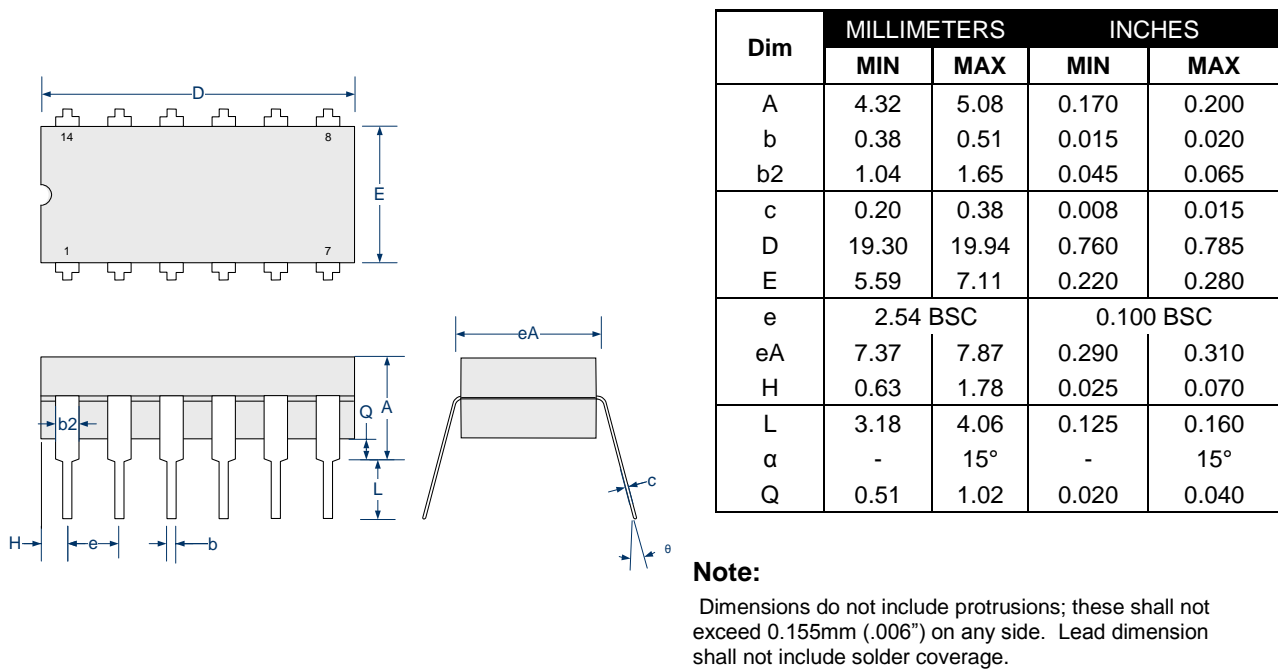
1. Dimensions do not include mold flash or protrusions; these shall not exceed 0.155mm (.006") on any side. Lead dimension shall not include solder coverage.

**Figure 26 • M 8-Pin PDIP Package Dimensions**

## PACKAGE OUTLINE DIMENSIONS

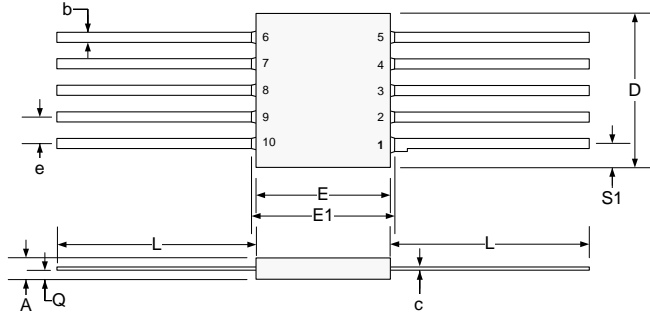


**Figure 27 • Y 8-Pin Cerdip Package Dimensions**



**Figure 28 • J 14-Pin Cerdip Package Dimensions**

## PACKAGE OUTLINE DIMENSIONS

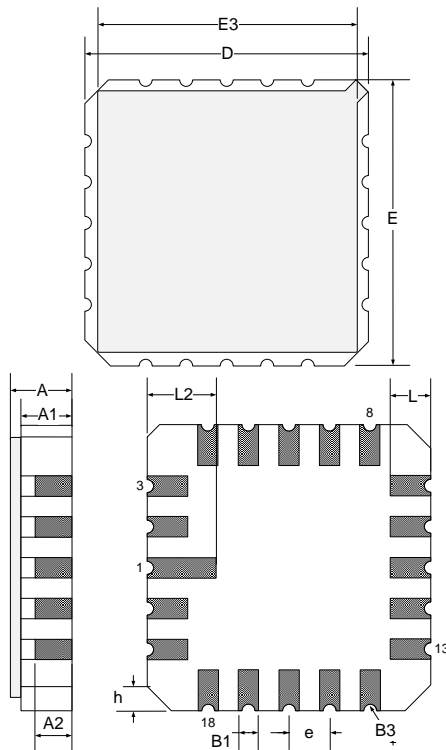


Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.45	1.70	0.057	0.067
b	0.25	0.483	0.010	0.019
c	0.102	0.152	0.004	0.006
D	-	7.37	-	0.290
E	6.04	6.40	0.238	0.252
E1	-	6.91	-	0.272
e	1.27 BSC		0.050 BSC	
L	6.35	9.40	0.250	0.370
Q	0.51	1.02	0.020	0.040
S1	0.20	0.38	0.008	0.015

**Note:**

1. Lead No. 1 is identified by tab on lead or dot on cover.
2. Leads are within 0.13mm (.0005") radius of the true position (TP) at maximum material condition.
3. Dimension "e" determines a zone within which all body and lead irregularities lie.

**Figure 29** - F 10-Pin Ceramic Flatpack Package Dimensions



Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
D/E	8.64	9.14	0.340	0.360
E3	-	8.128	-	0.320
e	1.270 BSC		0.050 BSC	
B1	0.635 TYP		0.025 TYP	
L	1.02	1.52	0.040	0.060
A	1.626	2.286	0.064	0.090
h	1.016 TYP		0.040 TYP	
A1	1.372	1.68	0.054	0.066
A2	-	1.168	-	0.046
L2	1.91	2.41	0.075	0.95
B3	0.203R		0.008R	

**Note:**

All exposed metalized area shall be gold plated 60 micro-inch minimum thickness over nickel plated unless otherwise specified in purchase order.

**Figure 30** - L 20-Pin Leadless Chip Carrier Package Dimensions



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