

# CS52843

## Current Mode PWM Control Circuit

The CS52843 provides all the necessary features to implement off-line fixed frequency current-mode control with a minimum number of external components.

The CS52843 incorporates a new precision temperature-controlled oscillator to minimize variations in frequency. An undervoltage lockout ensures that  $V_{REF}$  is stabilized before the output stage is enabled. In the CS52843 turn on is at 8.4 V and turn off at 7.6 V.

Other features include low start-up current, pulse-by-pulse current limiting, and a high-current totem pole output for driving capacitive loads, such as gate of a power MOSFET. The output is low in the off state, consistent with N-channel devices.

### Features

- Optimized for Off-Line Control
- Internally Temperature Compensated Oscillator
- $V_{REF}$  Stabilized before Output Stage is Enabled
- Very Low Start-Up Current 300  $\mu$ A (typ)
- Pulse-by-Pulse Current Limiting
- Improved Undervoltage Lockout
- Double Pulse Suppression
- 2.0% 5.0 Volt Reference
- High Current Totem Pole Output



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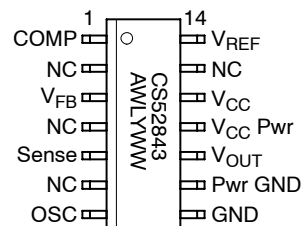
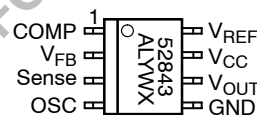


SO-8  
D SUFFIX  
CASE 751



SO-14  
D SUFFIX  
CASE 751A

### PIN CONNECTIONS AND MARKING DIAGRAMS



A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week

### ORDERING INFORMATION

Device	Package	Shipping
CS52843ED8	SO-8	95 Units/Rail
CS52843EDR8	SO-8	2500 Tape & Reel
CS52843ED14	SO-14	55 Units/Rail
CS52843EDR14	SO-14	2500 Tape & Reel

# CS52843

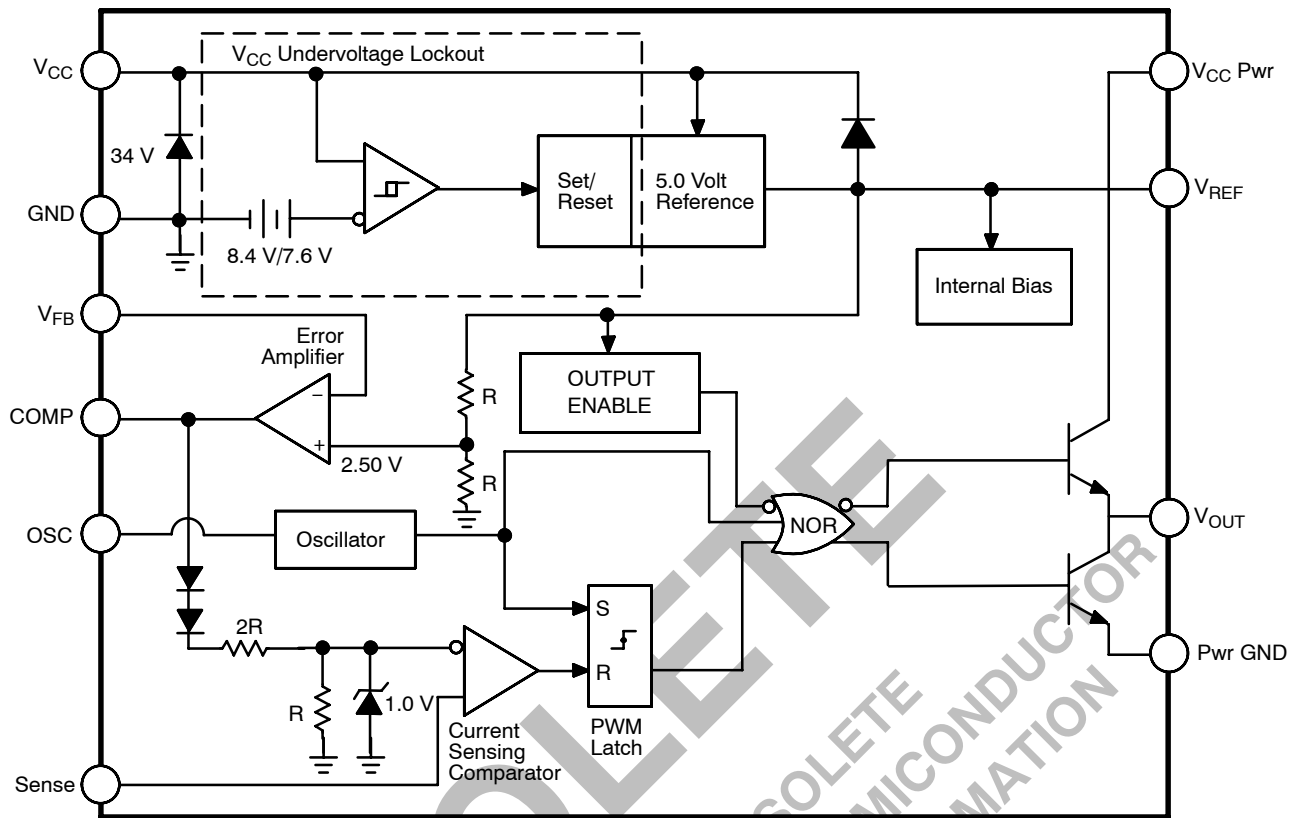


Figure 1. Block Diagram

## MAXIMUM RATINGS\*

Rating	Value	Unit
Supply Voltage ( $I_{CC} < 30 \text{ mA}$ )	Self Limiting	–
Supply Voltage (Low Impedance Source)	30	V
Output Current	$\pm 1.0$	A
Output Energy (Capacitive Load)	5.0	$\mu\text{J}$
Analog Inputs ( $V_{FB}$ , $V_{SENSE}$ )	–0.3 to 5.5	V
Error Amp Output Sink Current	10	mA
Lead Temperature Soldering:	Reflow: (SMD styles only) (Note 1)	230 peak
		°C

1. 60 second maximum above 183°C.

\*The maximum package power dissipation must be observed.

**ELECTRICAL CHARACTERISTICS** ( $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ ;  $V_{CC} = 15\text{ V}$  (Note 2.);  $R_T = 680\ \Omega$ ;  $C_T \nabla 0.022\ \mu\text{F}$  for triangle mode,  $R_T = 10\ \text{k}\Omega$ ;  $C_T \nabla 3.3\ \text{nF}$  sawtooth mode; unless otherwise specified.)

Parameter	Test Conditions	Min	Typ	Max	Unit
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#### Reference Section

Output Voltage	$T_J = 25^{\circ}\text{C}$ , $I_{REF} = 1.0\ \text{mA}$	4.9	5.0	5.1	V
Line Regulation	$12 \leq V_{CC} \leq 25\ \text{V}$	–	6.0	20	mV
Load Regulation	$1.0 \leq I_{REF} \leq 20\ \text{mA}$	–	6.0	25	mV
Temperature Stability	Note 2.	–	0.2	0.4	mV/ $^{\circ}\text{C}$
Total Output Variation	Line, Load, Temp. Note 2.	4.82	–	5.18	V
Output Noise Voltage	$10\ \text{Hz} \leq f \leq 10\ \text{kHz}$ , $T_J = 25^{\circ}\text{C}$ , Note 2.	–	50	–	$\mu\text{V}$
Long Term Stability	$T_A = 125^{\circ}\text{C}$ , 1000 Hrs. Note 2.	–	5.0	25	mV
Output Short Circuit	$T_A = 25^{\circ}\text{C}$	–30	–100	–180	mA

#### Oscillator Section

Initial Accuracy	Sawtooth Mode, $T_J = 25^{\circ}\text{C}$ , Note 2. Triangle Mode, $T_J = 25^{\circ}\text{C}$	47 44	52 52	57 60	kHz kHz
Voltage Stability	$12 \leq V_{CC} \leq 25\ \text{V}$	–	0.2	1.0	%
Temperature Stability	Sawtooth Mode $T_{MIN} \leq T_A \leq T_{MAX}$ Triangle Mode $T_{MIN} \leq T_A \leq T_{MAX}$ , Note 2.	– –	5.0 8.0	– –	% %
Amplitude	$V_{OSC}$ (peak to peak)	–	1.7	–	V
Discharge Current	$T_J = 25^{\circ}\text{C}$ $T_{MIN} \leq T_A \leq T_{MAX}$	7.3 6.8	8.3 –	9.3 9.8	mA mA

#### Error Amp Section

Input Voltage	$V_{COMP} = 2.5\ \text{V}$	2.42	2.50	2.58	V
Input Bias Current	$V_{FB} = 0\ \text{V}$	–	–0.3	–2.0	$\mu\text{A}$
$A_{VOL}$	$2.0 \leq V_{OUT} \leq 4.0\ \text{V}$	65	90	–	dB
Unity Gain Bandwidth	Note 2.	0.7	1.0	–	MHz
PSRR	$12 \leq V_{CC} \leq 25\ \text{V}$	60	70	–	dB
Output Sink Current	$V_{FB} = 2.7\ \text{V}$ , $V_{COMP} = 1.1\ \text{V}$	2.0	6.0	–	mA
Output Source Current	$V_{FB} = 2.3\ \text{V}$ , $V_{COMP} = 5.0\ \text{V}$	–0.5	–0.8	–	mA
$V_{OUT\ HIGH}$	$V_{FB} = 2.3\ \text{V}$ , $R_L = 15\ \text{k}\Omega$ to GND	5.0	6.0	–	V
$V_{OUT\ LOW}$	$V_{FB} = 2.7\ \text{V}$ , $R_L = 15\ \text{k}\Omega$ to $V_{REF}$	–	0.7	1.1	V

#### Current Sense Section

Gain	Notes 3 & 4.	2.85	3.0	3.15	V/V
Maximum Input Signal	$V_{COMP} = 5.0\ \text{V}$ , Note 3.	0.9	1.0	1.1	V
PSRR	$12 \leq V_{CC} \leq 25\ \text{V}$ , Note 3.	–	70	–	dB
Input Bias Current	$V_{SENSE} = 0\ \text{V}$	–	–2.0	–10	$\mu\text{A}$
Delay to Output	$T_J = 25^{\circ}\text{C}$ , Note 2.	–	150	300	ns

2. These parameters, although guaranteed, are not 100% tested in production.

3. Parameter measured at a trip point of latch with  $V_{FB} = 0$ .

4. Gain defined as:  $A = \frac{\Delta V_{COMP}}{\Delta V_{SENSE}}$ ;  $0 \leq V_{SENSE} \leq 0.8\ \text{V}$

**ELECTRICAL CHARACTERISTICS (continued)** ( $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ ;  $V_{CC} = 15\text{ V}$  (Note 2.);  $R_T = 680\ \Omega$ ;  $C_{T\frac{1}{2}} = 0.022\ \mu\text{F}$  for triangle mode,  $R_T = 10\text{ k}\Omega$ ;  $C_{T\frac{1}{2}} = 3.3\text{ nF}$  sawtooth mode; unless otherwise specified.)

Parameter	Test Conditions	Min	Typ	Max	Unit
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#### Output Section

Output Low Level	$I_{\text{SINK}} = 20\text{ mA}$	–	0.1	0.4	V
	$I_{\text{SINK}} = 200\text{ mA}$	–	1.5	2.2	V
Output High Level	$I_{\text{SOURCE}} = 20\text{ mA}$	13	13.5	–	V
	$I_{\text{SOURCE}} = 200\text{ mA}$	12	13.5	–	V
Rise Time	$T_J = 25^{\circ}\text{C}$ , $C_L = 1.0\text{ nF}$ , Note 5.	–	50	150	ns
Fall Time	$T_J = 25^{\circ}\text{C}$ , $C_L = 1.0\text{ nF}$ , Note 5.	–	50	150	ns
Output Leakage	UVLO Active $V_{\text{OUT}} = 0$	–	–0.01	–10	$\mu\text{A}$

#### Total Standby Current

Start-Up Current	–	–	300	500	$\mu\text{A}$
Operating Supply Current	$V_{\text{FB}} = V_{\text{SENSE}} = 0\text{ V}$ , $R_T = 10\text{ k}\Omega$ ; $C_{T\frac{1}{2}} = 3.3\text{ nF}$	–	11	17	mA
$V_{CC}$ Zener Voltage	$I_{CC} = 25\text{ mA}$	–	34	–	V

#### Undervoltage Lockout Section

Start Threshold	–	7.8	8.4	9.0	V
Min. Operating Voltage	After Turn On	7.0	7.6	8.2	V

5. These parameters, although guaranteed, are not 100% tested in production.

#### PACKAGE PIN DESCRIPTION

Package Lead Number		Lead Symbol	Function
SO–8	SO–14		
1	1	COMP	Error amp output, used to compensate error amplifier.
2	3	$V_{\text{FB}}$	Error amp inverting input.
3	5	SENSE	Noninverting input to Current Sense Comparator.
4	7	OSC	Oscillator timing network with capacitor to ground, resistor to $V_{\text{REF}}$ .
5	8	GND	Ground.
–	9	Pwr GND	Output driver ground.
6	10	$V_{\text{OUT}}$	Output drive pin.
–	11	$V_{CC\text{Pwr}}$	Output driver positive supply.
7	12	$V_{CC}$	Positive power supply.
8	14	$V_{\text{REF}}$	Output of 5.0 V internal reference.
–	2, 4, 6, 13	NC	No Connection.

## TYPICAL PERFORMANCE CHARACTERISTICS

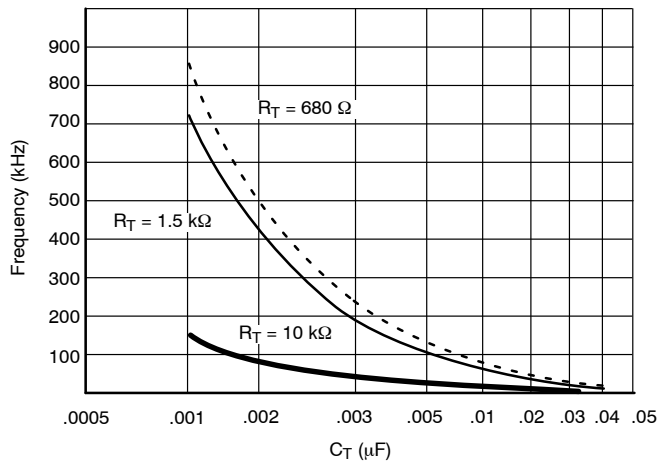
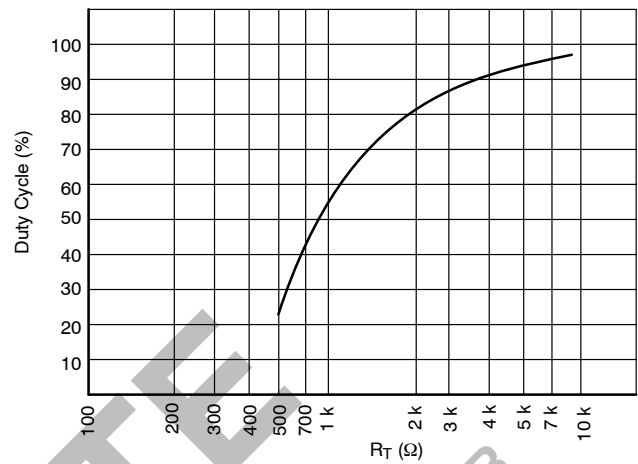
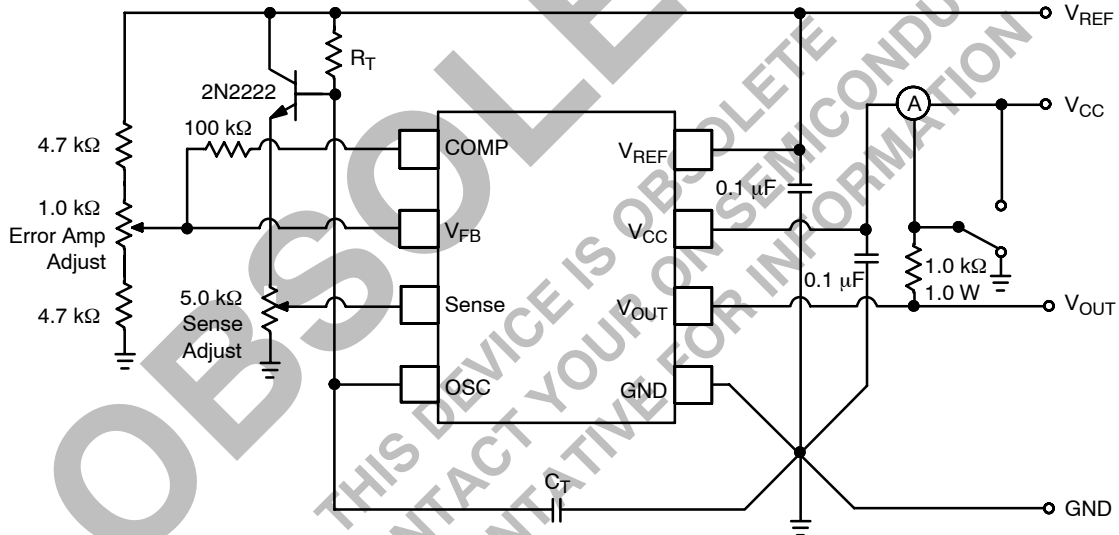
Figure 2. Oscillator Frequency vs  $C_T$ Figure 3. Oscillator Duty Cycle vs  $R_T$ 

Figure 4. Test Circuit Open Loop Laboratory Test Fixture

## CIRCUIT DESCRIPTION

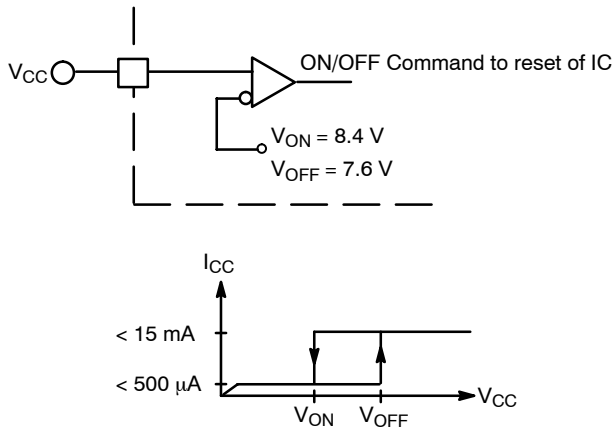


Figure 5. Startup Voltage for the CS52843

### Undervoltage Lockout

During Undervoltage Lockout (Figure 5), the output driver is biased to sink minor amounts of current. The output should be shunted to ground with a resistor to prevent activating the power switch with extraneous leakage currents.

### PWM Waveform

To generate the PWM waveform, the control voltage from the error amplifier is compared to a current sense signal which represents the peak output inductor current (Figure 6). An increase in  $V_{CC}$  causes the inductor current slope to increase, thus reducing the duty cycle. This is an inherent feed-forward characteristic of current mode control, since the control voltage does not have to change during changes of input supply voltage.

When the power supply sees a sudden large output current increase, the control voltage will increase allowing the duty cycle to momentarily increase. Since the duty cycle tends to exceed the maximum allowed to prevent transformer saturation in some power supplies, the internal oscillator waveform provides the maximum duty cycle clamp as programmed by the selection of oscillator timing components.

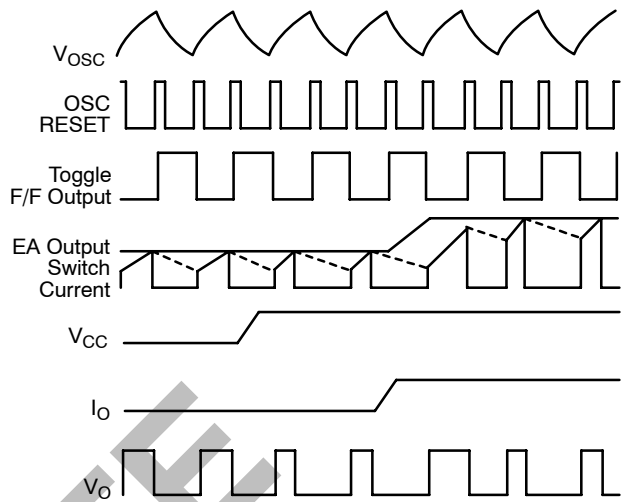


Figure 6. Timing Diagram

### Setting the Oscillator

The times  $t_c$  and  $t_d$  can be determined as follows:

$$t_c = R_T C_T \ln \left( \frac{V_{REF} - V_{LOWER}}{V_{REF} - V_{UPPER}} \right)$$

$$t_d = R_T C_T \ln \left( \frac{V_{REF} - I_d R_T V_{LOWER}}{V_{REF} - I_d R_T - V_{UPPER}} \right)$$

Substituting in typical values for the parameters in the above formulas:

$$V_{REF} = 5.0 \text{ V}, V_{UPPER} = 2.7 \text{ V},$$

$$V_{LOWER} = 1.0 \text{ V}, I_d = 8.3 \text{ mA}$$

then

$$t_c \approx 0.5534 R_T C_T$$

$$t_d = R_T C_T \ln \left( \frac{2.3 - 0.0083 R_T}{4.0 - 0.0083 R_T} \right)$$

For better accuracy  $R_T$  should be  $\geq 10 \text{ k}\Omega$ .

### Grounding

High peak currents associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected close to GND in a single point ground.

The transistor and  $5.0 \text{ k}\Omega$  potentiometer are used to sample the oscillator waveform and apply an adjustable ramp to Sense.

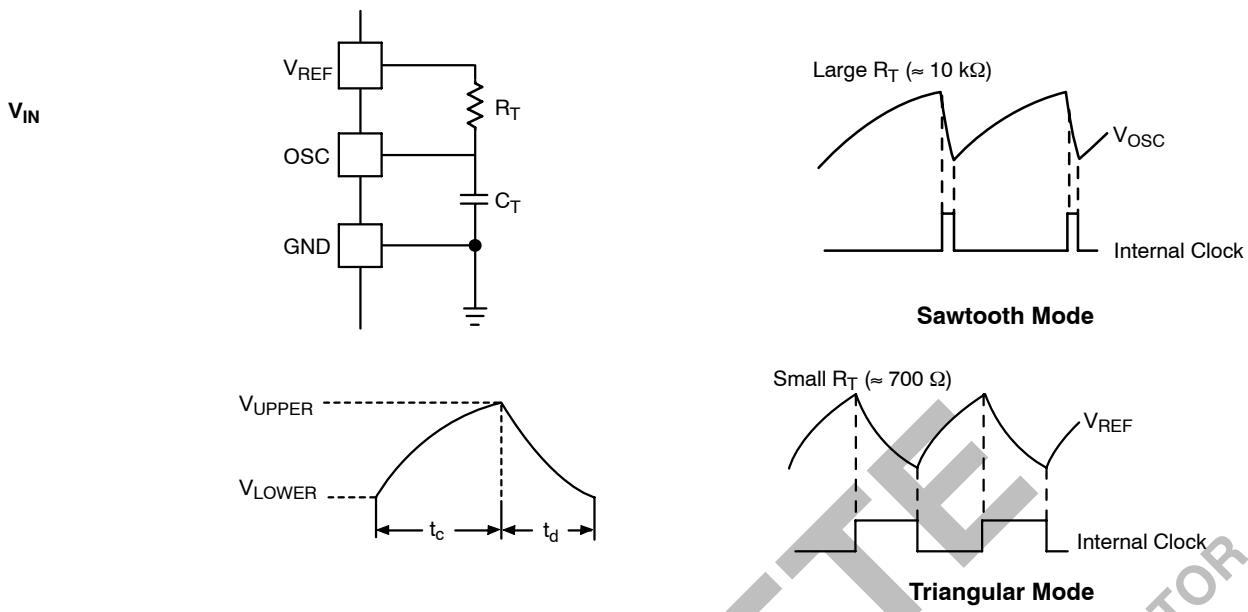
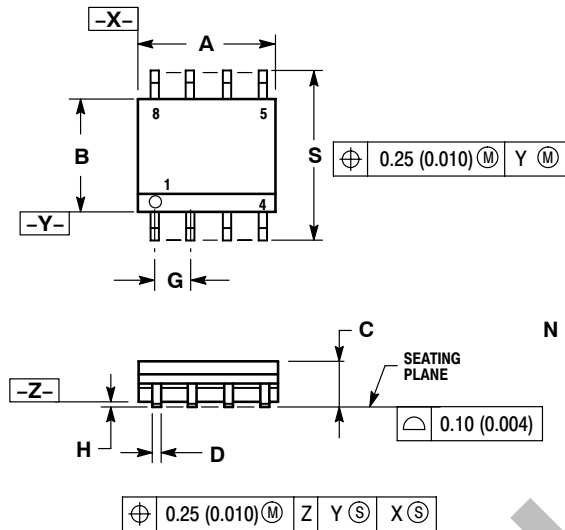


Figure 7. Oscillator Timing Network and Parameters

## PACKAGE DIMENSIONS

SO-8  
DF SUFFIX  
CASE 751-07  
ISSUE W

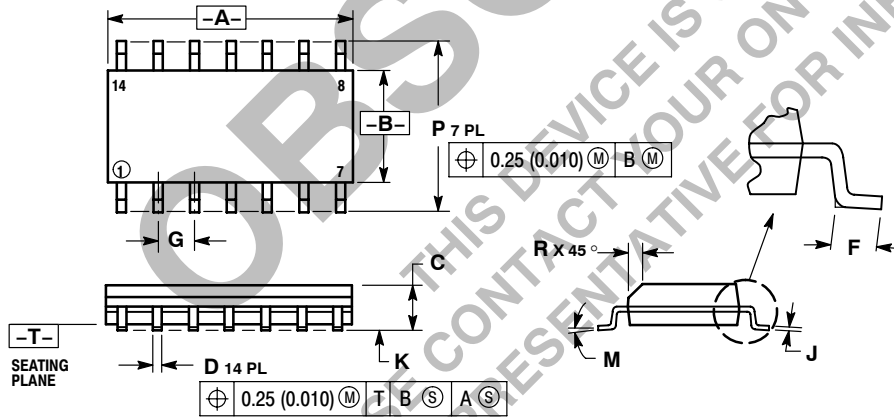


## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. 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.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SO-14  
D SUFFIX  
CASE 751A-03  
ISSUE F



## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
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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.


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	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	0.228	0.244
R	0.25	0.50	0.010	0.019

## PACKAGE THERMAL DATA

Parameter		SO-8	SO-14	Unit
$R_{\theta JC}$	Typical	45	30	°C/W
$R_{\theta JA}$	Typical	165	125	°C/W

**OBSOLETE**

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