

CS2842A, CS3842A, CS2843A, CS3843A



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Off-Line Current Mode PWM Control Circuit with Undervoltage Lockout

The CS284XA, CS384XA provides all the necessary features to implement off-line fixed frequency current-mode control with a minimum number of external components.

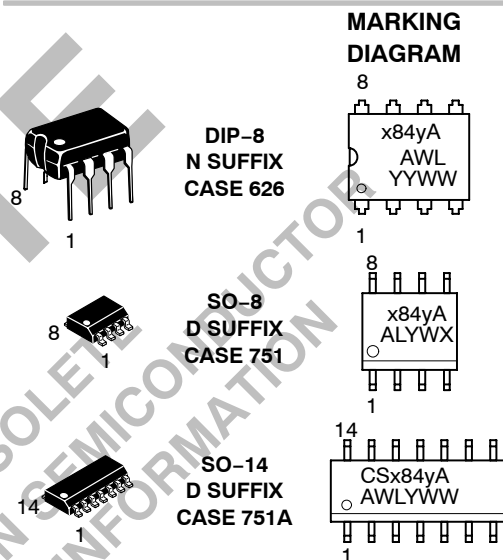
The CS384XA family incorporates a new precision temperature-controlled oscillator with an internally trimmed discharge current to minimize variations in frequency. A precision duty-cycle clamp eliminates the need for an external oscillator when a 50% duty-cycle is used. Duty-cycles greater than 50% are also possible. On board logic ensures that V_{REF} is stabilized before the output stage is enabled. Ion implant resistors provide tighter control of undervoltage lockout.

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

The CS384XA series of current-mode control ICs are available in 8 and 14 lead packages for surface mount (SO) applications as well as 8 lead PDIP packages.

Features

- Optimized for Off-line Control
- Internally Trimmed Temperature Compensated Oscillator
- Maximum Duty-Cycle Clamp
- V_{REF} Stabilized Before Output Stage is Enabled
- Low Startup Current
- Pulse-By-Pulse Current Limiting
- Improved Undervoltage Lockout
- Double Pulse Suppression
- 1.0% Trimmed Bandgap Reference
- High Current Totem Pole Output



x = 2 or 3
 y = 2 or 3
 A = Assembly Location
 WL, L = Wafer Lot
 YY, Y = Year
 WW, W = Work Week

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

CS2842A, CS3842A, CS2843A, CS3843A

PIN CONNECTIONS

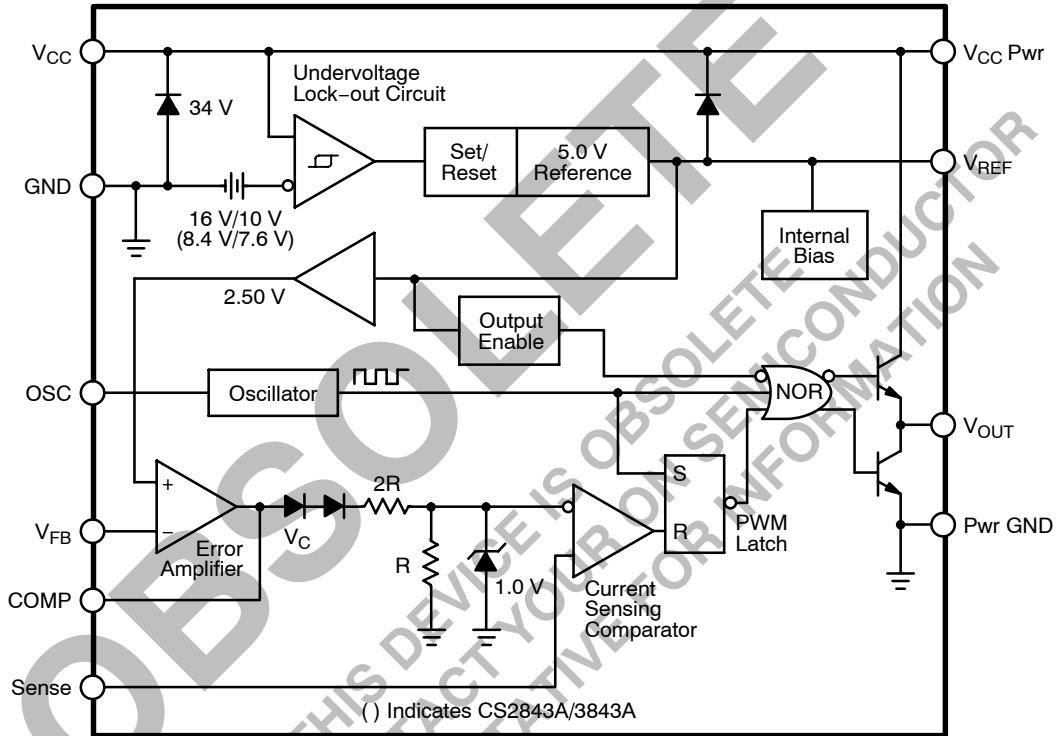
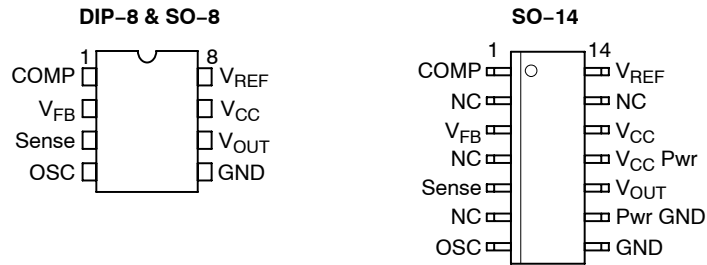


Figure 1. Block Diagram

CS2842A, CS3842A, CS2843A, CS3843A

MAXIMUM RATINGS*

| Rating | Value | Unit |
|---|--|--|
| Supply Voltage ($I_{CC} < 30 \text{ mA}$) | Self Limiting | – |
| Supply Voltage (Low Impedance Source) | 30 | V |
| Output Current | ± 1.0 | A |
| Output Energy (Capacitive Load) | 5.0 | μJ |
| Analog Inputs (V_{FB} , Sense) | –0.3 to + 5.5 | V |
| Error Amp Output Sink Current | 10 | mA |
| Package Thermal Resistance, PDIP–8 Junction–to–Case, $R_{\theta JC}$ Junction–to–Ambient, $R_{\theta JA}$ | 52 100 | $^{\circ}\text{C/W}$ $^{\circ}\text{C/W}$ |
| Package Thermal Resistance, SO–8 Junction–to–Case, $R_{\theta JC}$ Junction–to–Ambient, $R_{\theta JA}$ | 45 165 | $^{\circ}\text{C/W}$ $^{\circ}\text{C/W}$ |
| Package Thermal Resistance, SO–14 Junction–to–Case, $R_{\theta JC}$ Junction–to–Ambient, $R_{\theta JA}$ | 30 125 | $^{\circ}\text{C/W}$ $^{\circ}\text{C/W}$ |
| Lead Temperature Soldering: | Wave Solder (through hole styles only) (Note 1) Reflow (SMD styles only) (Note 2) | 260 peak 230 peak $^{\circ}\text{C}$ $^{\circ}\text{C}$ |

1. 10 second maximum.

2. 60 second maximum above 183°C.

*The maximum package power dissipation must be observed.

ELECTRICAL CHARACTERISTICS

($-25^{\circ} \leq T_A \leq 85^{\circ}$ for CS2842A/CS2843A, $0^{\circ} \leq T_A \leq 70^{\circ}$ for CS3842A/CS3843A.
 $V_{CC} = 15 \text{ V}^*$; $R_T = 680 \Omega$, $C_T = 0.022 \mu\text{F}$ for triangular mode, $R_T = 10 \text{ k}\Omega$, $C_T = 3.3 \text{ nF}$ for sawtooth mode (see Figure 7);
 unless otherwise stated.)

| Characteristic | Test Conditions | CS2842A/CS2843A | | | CS3842A/CS3843A | | | Unit |
|--------------------------|---|-----------------|------|------|-----------------|------|------|------------------------------|
| | | Min | Typ | Max | Min | Typ | Max | |
| Reference Section | | | | | | | | |
| Output Voltage | $T_J = 25^{\circ}\text{C}$, $I_{OUT} = 1.0 \text{ mA}$ | 4.95 | 5.00 | 5.05 | 4.90 | 5.00 | 5.10 | V |
| Line Regulation | $12 \leq V_{IN} \leq 25 \text{ V}$ | – | 6.0 | 20 | – | 6.0 | 20 | mV |
| Load Regulation | $1.0 \leq I_{OUT} \leq 20 \text{ mA}$ | – | 6.0 | 25 | – | 6.0 | 25 | mV |
| Temperature Stability | Note 3. | – | 0.2 | 0.4 | – | 0.2 | 0.4 | $\text{mV}/^{\circ}\text{C}$ |
| Total Output Variation | Line, Load, Temperature (Note 3.) | 4.90 | – | 5.10 | 4.82 | – | 5.18 | V |
| Output Noise Voltage | $10 \text{ Hz} \leq f \leq 10 \text{ kHz}$, $T_J = 25^{\circ}\text{C}$ (Note 3.) | – | 50 | – | – | 50 | – | μV |
| Long Term Stability | $T_A = 125^{\circ}\text{C}$, 1.0 kHrs. (Note 3.) | – | 5.0 | 25 | – | 5.0 | 25 | mV |
| Output Short Circuit | $T_A = 25^{\circ}\text{C}$ | –30 | –100 | –180 | –30 | –100 | –180 | mA |

Oscillator Section

| | | | | | | | | |
|-----------------------|--|-----|-----|-----|-----|-----|-----|-----|
| Initial Accuracy | Sawtooth Mode (see Figure 7), $T_J = 25^{\circ}\text{C}$ | 47 | 52 | 57 | 47 | 52 | 57 | kHz |
| | Triangular Mode (see Figure 7), $T_J = 25^{\circ}\text{C}$ | 47 | 52 | 57 | 44 | 52 | 60 | kHz |
| Voltage Stability | $12 \leq V_{CC} \leq 25 \text{ V}$ | – | 0.2 | 1.0 | – | 0.2 | 1.0 | % |
| Temperature Stability | Sawtooth Mode $T_{MIN} \leq T_A \leq T_{MAX}$ (Note 3.) | – | 5.0 | – | – | 5.0 | – | % |
| | Triangular Mode $T_{MIN} \leq T_A \leq T_{MAX}$ (Note 3.) | – | 8.0 | – | – | 8.0 | – | % |
| Amplitude | OSC peak to peak | – | 1.7 | – | – | 1.7 | – | V |
| Discharge Current | $T_J = 25^{\circ}\text{C}$ | 7.5 | 8.3 | 9.3 | 7.5 | 8.3 | 9.3 | mA |
| | $T_{MIN} \leq T_A \leq T_{MAX}$ | 7.2 | – | 9.5 | 7.2 | – | 9.5 | mA |

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

*Adjust V_{CC} above the start threshold before setting at 15 V.

CS2842A, CS3842A, CS2843A, CS3843A

ELECTRICAL CHARACTERISTICS (continued) ($-25^{\circ} \leq T_A \leq 85^{\circ}$ for CS2842A/CS2843A, $0^{\circ} \leq T_A \leq 70^{\circ}$ for CS3842A/CS3843A.
 $V_{CC} = 15\text{ V}^*$; $R_T = 680\ \Omega$, $C_T = 0.022\ \mu\text{F}$ for triangular mode, $R_T = 10\ \text{k}\Omega$, $C_T = 3.3\ \text{nF}$ for sawtooth mode (see Figure 7);
 unless otherwise stated.)

| Characteristic | Test Conditions | CS2842A/CS2843A | | | CS3842A/CS3843A | | | Unit |
|----------------|-----------------|-----------------|-----|-----|-----------------|-----|-----|------|
| | | Min | Typ | Max | Min | Typ | Max | |

Error Amp Section

| | | | | | | | | |
|-----------------------|--|------|------|------|------|------|------|---------------|
| Input Voltage | $V_{COMP} = 2.5\ \text{V}$ | 2.45 | 2.50 | 2.55 | 2.42 | 2.50 | 2.58 | V |
| Input Bias Current | $V_{FB} = 0$ | - | -0.3 | -1.0 | - | -0.3 | -2.0 | μA |
| A_{VOL} | $2.0 \leq V_{OUT} \leq 4.0\ \text{V}$ | 65 | 90 | - | 65 | 90 | - | dB |
| Unity Gain Bandwidth | Note 4. | 0.7 | 1.0 | - | 0.7 | 1.0 | - | MHz |
| PSRR | $12 \leq V_{CC} \leq 25\ \text{V}$ | 60 | 70 | - | 60 | 70 | - | dB |
| Output Sink Current | $V_{FB} = 2.7\ \text{V}$, $V_{COMP} = 1.1\ \text{V}$ | 2.0 | 6.0 | - | 2.0 | 6.0 | - | mA |
| Output Source Current | $V_{FB} = 2.3\ \text{V}$, $V_{COMP} = 5.0\ \text{V}$ | -0.5 | -0.8 | - | -0.5 | -0.8 | - | mA |
| V_{OUT} High | $V_{FB} = 2.3\ \text{V}$, $15\ \text{k}\Omega$ to ground | 5.0 | 6.0 | - | 5.0 | 6.0 | - | V |
| V_{OUT} Low | $V_{FB} = 2.7\ \text{V}$, $15\ \text{k}\Omega$ to V_{REF} | - | 0.7 | 1.1 | - | 0.7 | 1.1 | V |

Current Sense Section

| | | | | | | | | |
|----------------------|--|------|------|------|------|------|------|---------------|
| Gain | Notes 5 & 6. | 2.85 | 3.00 | 3.15 | 2.85 | 3.00 | 3.15 | V/V |
| Maximum Input Signal | $V_{COMP} = 5.0\ \text{V}$ (Note 5.) | 0.9 | 1.0 | 1.1 | 0.9 | 1.0 | 1.1 | V |
| PSRR | $12 \leq V_{CC} \leq 25\ \text{V}$ (Note 5.) | - | 70 | - | - | 70 | - | dB |
| Input Bias Current | $V_{SENSE} = 0$ | - | -2.0 | -10 | - | -2.0 | -10 | μA |
| Delay to Output | $T_J = 25^{\circ}\text{C}$ (Note 4.) | - | 150 | 300 | - | 150 | 300 | ns |

Output Section

| | | | | | | | | |
|-------------------|---|----|-------|--------|----|-------|--------|---------------|
| Output Low Level | $I_{SINK} = 20\ \text{mA}$ | - | 0.1 | 0.4 | - | 0.1 | 0.4 | V |
| | $I_{SINK} = 200\ \text{mA}$ | - | 1.5 | 2.2 | - | 1.5 | 2.2 | V |
| Output High Level | $I_{SOURCE} = 20\ \text{mA}$ | 13 | 13.5 | - | 13 | 13.5 | - | V |
| | $I_{SOURCE} = 200\ \text{mA}$ | 12 | 13.5 | - | 12 | 13.5 | - | V |
| Rise Time | $T_J = 25^{\circ}\text{C}$, $C_L = 1.0\ \text{nF}$ (Note 4.) | - | 50 | 150 | - | 50 | 150 | ns |
| Fall Time | $T_J = 25^{\circ}\text{C}$, $C_L = 1.0\ \text{nF}$ (Note 4.) | - | 50 | 150 | - | 50 | 150 | ns |
| Output Leakage | UVLO Active, $V_{OUT} = 0$ | - | -0.01 | -10.00 | - | -0.01 | -10.00 | μA |

Total Standby Current

| | | | | | | | | |
|--------------------------|---|----|-----|-----|----|-----|-----|----|
| Startup Current | - | - | 0.5 | 1.0 | - | 0.5 | 1.0 | mA |
| Operating Supply Current | $V_{FB} = V_{SENSE} = 0\ \text{V}$, $R_T = 10\ \text{k}\Omega$, $C_T = 3.3\ \text{nF}$ | 11 | 17 | - | 11 | 17 | - | mA |
| V_{CC} Zener Voltage | $I_{CC} = 25\ \text{mA}$ | - | 34 | - | - | 34 | - | V |

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

5. Parameters measured at trip point of latch with $V_{FB} = 0$.

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

*Adjust V_{CC} above the start threshold before setting at 15 V.

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ELECTRICAL CHARACTERISTICS (continued) ($-25^{\circ} \leq T_A \leq 85^{\circ}$ for CS2842A/CS2843A, $0^{\circ} \leq T_A \leq 70^{\circ}$ for CS3842A/CS3843A. $V_{CC} = 15\text{ V}^*$; $R_T = 680\ \Omega$, $C_T = 0.022\ \mu\text{F}$ for triangular mode, $R_T = 10\ \text{k}\Omega$, $C_T = 3.3\ \text{nF}$ for sawtooth mode (see Figure 7); unless otherwise stated.)

| Characteristic | Test Conditions | CS2842A | | | CS3842A | | | CS2843A/CS3843A | | | Unit |
|-------------------------------------|-----------------|---------|-----|-----|---------|-----|------|-----------------|-----|-----|------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Undervoltage Lockout Section | | | | | | | | | | | |
| Start Threshold | – | 15 | 16 | 17 | 14.5 | 16 | 17.5 | 7.8 | 8.4 | 9.0 | V |
| Min. Operating Voltage | After Turn On | 9.0 | 10 | 11 | 8.5 | 10 | 11.5 | 7.0 | 7.6 | 8.2 | V |

*Adjust V_{CC} above the start threshold before setting at 15 V.

PACKAGE PIN DESCRIPTION

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

TYPICAL PERFORMANCE CHARACTERISTICS

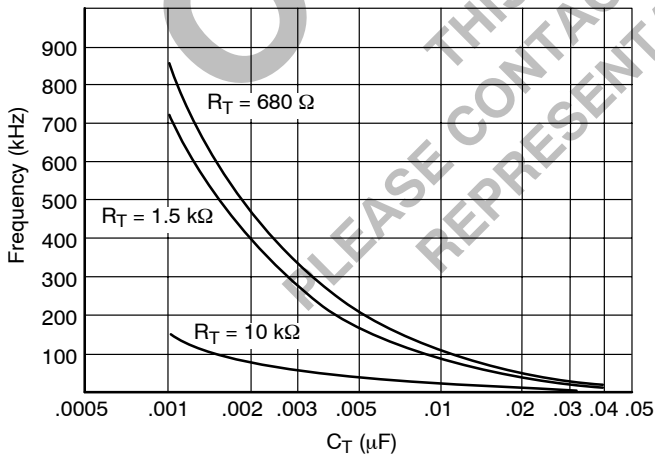


Figure 2. Oscillator Frequency vs. C_T

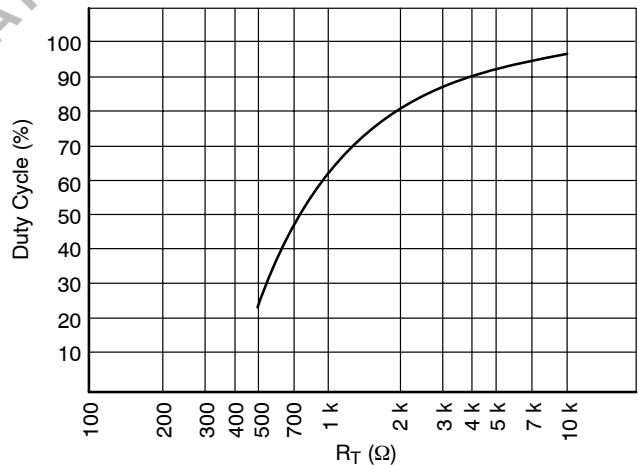


Figure 3. Oscillator Duty Cycle vs. R_T

CS2842A, CS3842A, CS2843A, CS3843A

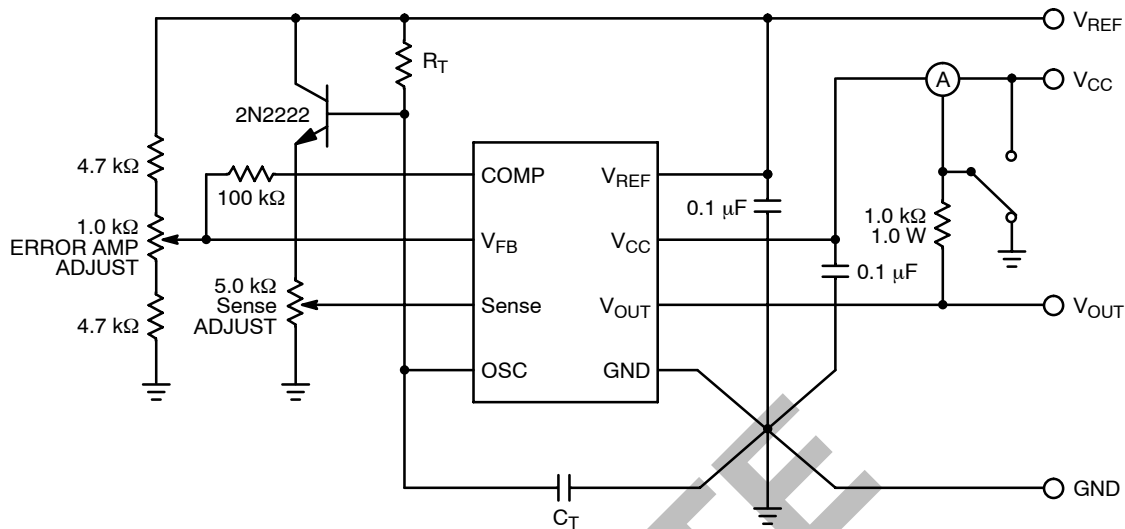


Figure 4. Test Circuit

CIRCUIT DESCRIPTION

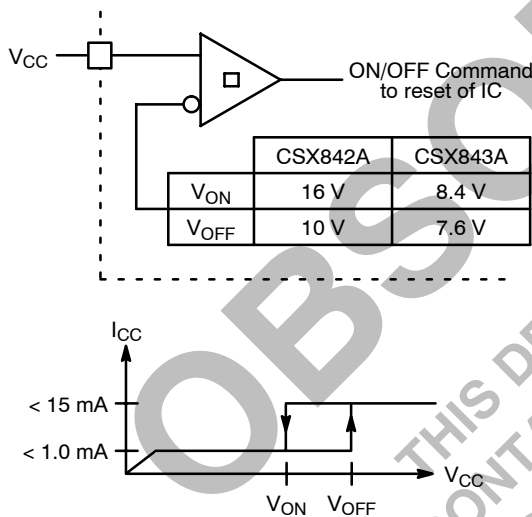


Figure 5. Typical Undervoltage Characteristics

Undervoltage Lockout

During Undervoltage Lockout (Figure 5), the output driver is biased to a high impedance state. The output should be shunted to ground with a resistor to prevent output leakage current from activating the power switch.

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.

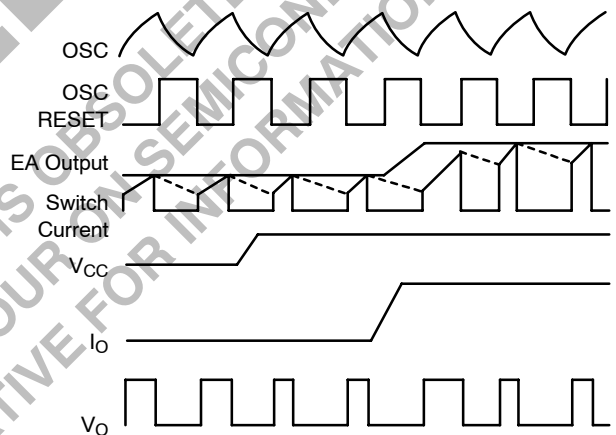


Figure 6. Timing Diagram for Key CS2841B Parameters

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 components.

Setting the Oscillator

Oscillator timing capacitor, C_T, is charged by V_{REF} through R_T and discharged by an internal current source. During the discharge time, the internal clock signal blanks out the output to the Low state, thus providing a user selected maximum duty cycle clamp. Charge and discharge times are determined by the formula:

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

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

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

$$V_{REF} = 5.0 \text{ V}$$

$$V_{upper} = 2.7 \text{ V}$$

$$V_{lower} = 1.0 \text{ V}$$

$$I_d = 8.3 \text{ mA}$$

$$t_c \approx 0.5534 R_T C_T$$

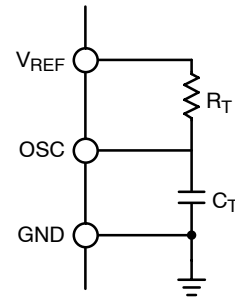
$$t_d = R_T C_T \ln \left(\frac{2.3 - 0.0083 R_T}{4.0 - 0.0083 R_T} \right)$$

The frequency and maximum duty cycle can be determined using the Typical Performance Characteristic graphs.

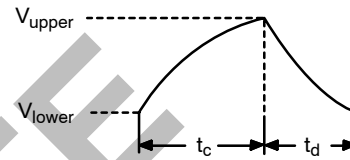
Grounding

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

The transistor and 5.0 kΩ potentiometer, shown in the test circuit, are used to sample the oscillator waveform and apply and adjustable ramp to Sense.

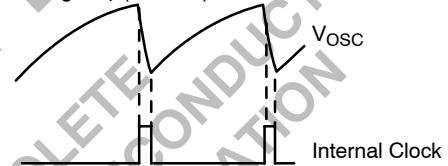


Timing Parameters



Sawtooth Mode

Large R_T ($\approx 10 \text{ k}\Omega$)



Triangular Mode

Small R_T ($\approx 700 \text{ k}\Omega$)

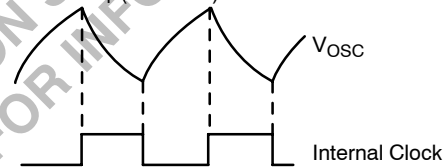


Figure 7. Oscillator Timing Network and Parameters

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ORDERING INFORMATION

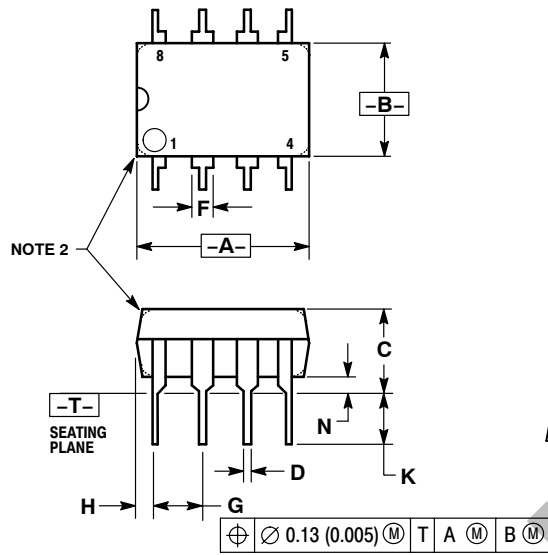
| Device | Temperature Range | Package | Shipping |
|--------------|-------------------|---------|------------------|
| CS2842ALN8 | -25°C to 85°C | DIP-8 | 50 Units/Rail |
| CS2843ALN8 | | DIP-8 | 50 Units/Rail |
| CS2842ALD14 | | SO-14 | 55 Units/Rail |
| CS2842ALDR14 | | SO-14 | 2500 Tape & Reel |
| CS3842AGN8 | 0°C to 70°C | DIP-8 | 50 Units/Rail |
| CS3842AGD8 | | SO-8 | 98 Units/Rail |
| CS3842AGDR8 | | SO-8 | 2500 Tape & Reel |
| CS3842AGD14 | | SO-14 | 55 Units/Rail |
| CS3842AGDR14 | | SO-14 | 2500 Tape & Reel |
| CS3843AGN8 | | DIP-8 | 50 Units/Rail |
| CS3843AGD8 | | SO-8 | 98 Units/Rail |
| CS3843AGDR8 | | SO-8 | 2500 Tape & Reel |
| CS3843AGD14 | | SO-14 | 55 Units/Rail |
| CS3843AGDR14 | | SO-14 | 2500 Tape & Reel |

OBSOLETE
 THIS DEVICE IS OBSOLETE
 PLEASE CONTACT YOUR ON SEMICONDUCTOR
 REPRESENTATIVE FOR INFORMATION

CS2842A, CS3842A, CS2843A, CS3843A

PACKAGE DIMENSIONS

DIP-8
N SUFFIX
CASE 626-05
ISSUE L

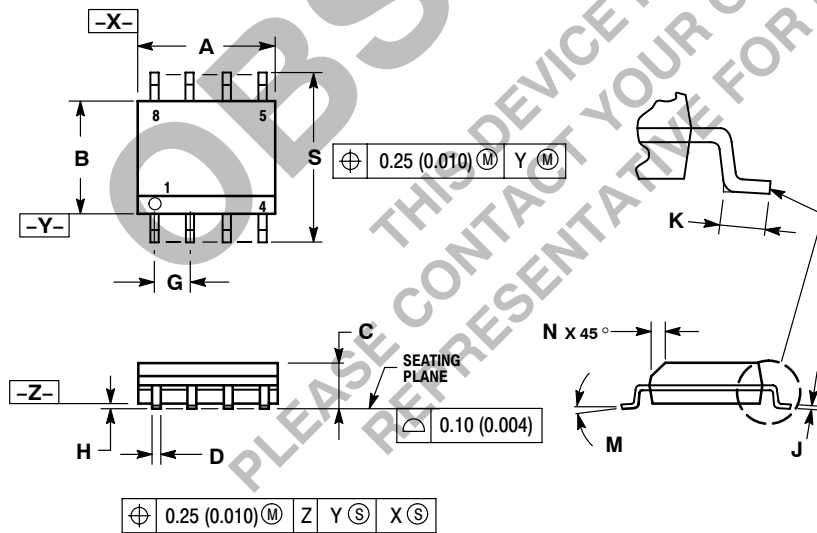


NOTES:

1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 9.40 | 10.16 | 0.370 | 0.400 |
| B | 6.10 | 6.60 | 0.240 | 0.260 |
| C | 3.94 | 4.45 | 0.155 | 0.175 |
| D | 0.38 | 0.51 | 0.015 | 0.020 |
| F | 1.02 | 1.78 | 0.040 | 0.070 |
| G | 2.54 BSC | | 0.100 BSC | |
| H | 0.76 | 1.27 | 0.030 | 0.050 |
| J | 0.20 | 0.30 | 0.008 | 0.012 |
| K | 2.92 | 3.43 | 0.115 | 0.135 |
| L | 7.62 BSC | | 0.300 BSC | |
| M | --- | 10° | --- | 10° |
| N | 0.76 | 1.01 | 0.030 | 0.040 |

SO-8
D SUFFIX
CASE 751-07
ISSUE W



NOTES:

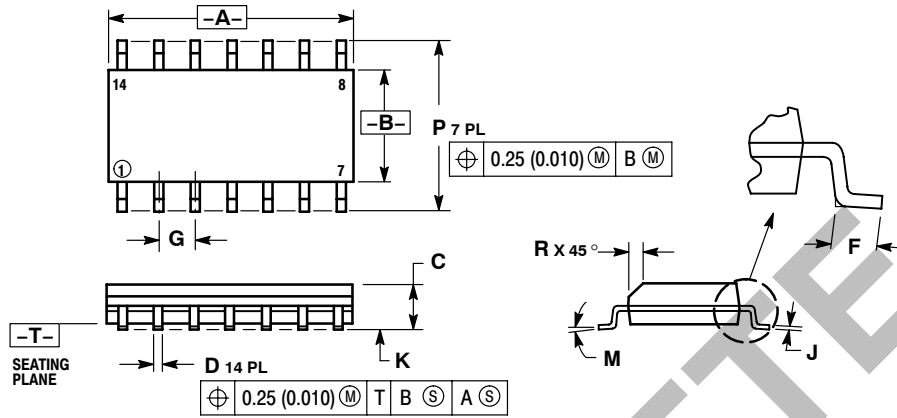
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL 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 |

CS2842A, CS3842A, CS2843A, CS3843A

PACKAGE DIMENSIONS

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.
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 | 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 |

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