CS3524A

Voltage Mode PWM Control Circuit with 200 mA Output Drivers

The CS3524A PWM control circuit retains the same versatile architecture of the industry standard CS3524 (SG3524) while adding substantial improvements.

The CS3524 is pin–compatible with "non–A" versions, and in most applications can be directly interchanged. The CS3524A, however, eliminates many of the design restrictions which had previously required additional external circuitry.

The CS3524A includes a precision 5.0 V reference trimmed to ±1% accuracy (eliminating the need for potentiometer adjustments), an error amplifier with an output voltage swing extending to 5.0 V, and a current sense amplifier useful in either the ground or power supply output lines. The uncommitted 60 V, 200 mA NPN output pair greatly enhances the output drive capability.

The CS3524A features an undervoltage lockout circuit which disables all internal circuitry (except the reference) until the input voltage has risen to 8.0 V. This holds standby current low until turn–on, and greatly simplifies the design of low power, off–line supplies. The turn–on circuit has approximately 600 mV of hysteresis for jitter free activation.

Other improvements include a PWM latch that insures freedom from multiple pulsing within a period, even in noisy environments; logic to eliminate double pulsing on a single output, a 200 ns external shutdown capability, and automatic thermal protection from excessive chip temperature. The oscillator circuit is usable to 500 kHz and is easier to synchronize with an external clock pulse.
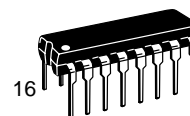
Features

- Precision Reference Internally Trimmed to ±1%
- Current Limit
- Undervoltage Lockout
- Start–Up Supply Current < 4.0 mA
- Output to 200 mA
- 60 V Output Capability
- Wide Common–Mode Input Range for Error and Current Limit Amplifiers
- PWM Latch Insures Single Pulse per Period
- Double Pulse Suppression
- 200 ns Shutdown
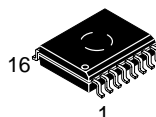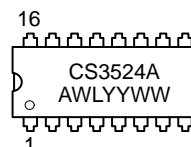- Guaranteed Frequency
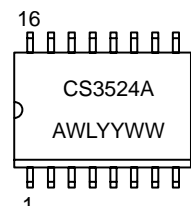- Thermal Shutdown

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MARKING DIAGRAMS

DIP–16
N SUFFIX
CASE 648

16
CS3524A
AWLYYWW
1

SO–16L
DW SUFFIX
CASE 751G

16
CS3524A
AWLYYWW
1

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

PIN CONNECTIONS

EA–	1		V_{REF}
EA+			V_{IN}
SYNC			E_B
I_{SENSE+}			V_{OUTB}
I_{SENSE-}			V_{OUTA}
R_T			E_A
C_T			SHUTDOWN
GND			COMP
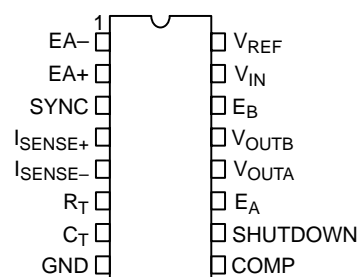
ORDERING INFORMATION

Device	Package	Shipping
CS3524AGN16	DIP–16	25 Units/Rail
CS3524AGDW16	SO–16L	46 Units/Rail
CS3524AGDWR16	SO–16L	1000 Tape & Reel

December, 2000 – Rev. 3

1

CS3524A
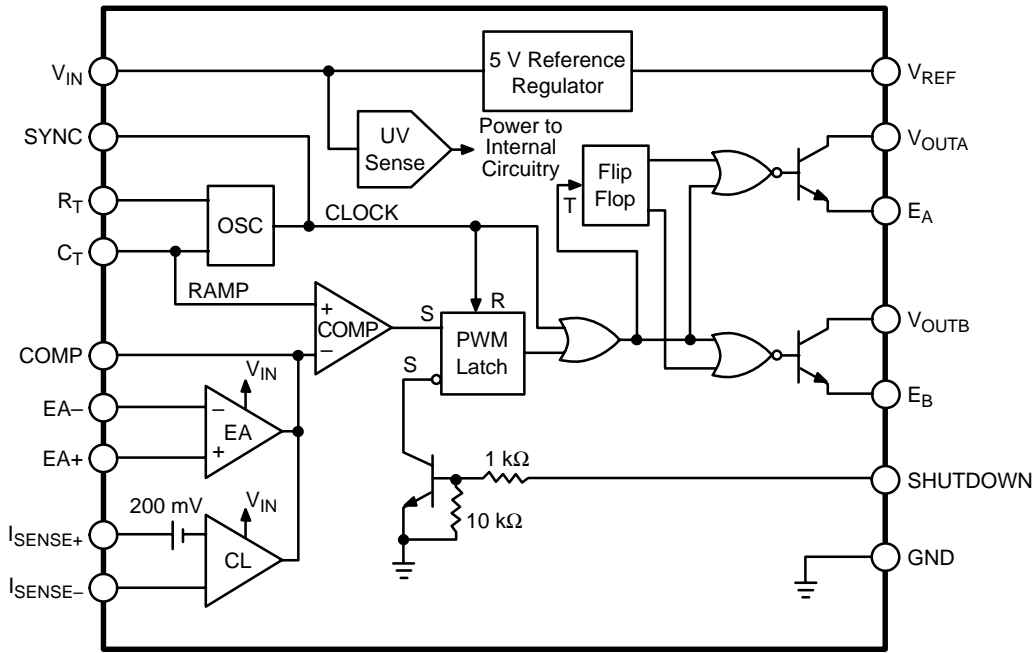
Figure 1. Block Diagram

ABSOLUTE MAXIMUM RATINGS*

Rating		Value	Unit
Supply Voltage (V_{IN})		40	V
Collector Supply Voltage (V_{CC})		60	V
Output Current (Each Output)		200	mA
Reference Output Current		50	mA
Oscillator Charging Current		5.0	mA
Power Dissipation at T_A = 25°C		1000	mW
Power Dissipation at T_J = +25°C Derate for Case Temperature above +25°C		2000 16	mW mW/°C
Storage Temperature Range		−65 to +150	°C
Lead Temperature Soldering	Wave Solder (through hole styles only) Note 1. Reflow (SMD styles only) Note 2.	260 peak 230 peak	°C °C

1. 10 seconds max.

2. 60 seconds max above 183°C

*The maximum package power dissipation must be observed.

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ELECTRICAL CHARACTERISTICS (0°C ≤ T_A ≤ +70°C, V_{IN} = V_{CC} = 20 V; unless otherwise specified.)

Characteristic	Test Conditions	Min	Typ	Max	Unit
Turn–On Characteristics					
Input Voltage	Operating Range after Turn–On	8.0	–	40	V
Turn–On Threshold	–	5.5	7.5	8.5	V
Turn–On Current	V_{IN} Turn–On – 100 mV	–	2.5	4.0	mA
Operating Current	V_{IN} = 8.0 to 40 V	–	5.0	10	mA
Turn–On Hysteresis (Note 3.)	–	–	0.6	–	V
Reference Section					
Output Voltage	T_A = 25°C	4.9	5.0	5.2	V
Line Regulation	V_{IN} = 10 to 40 V	–	10	30	mV
Load Regulation	I_L = 0 to 20 mA	–	20	50	mA
Temperature Stability (Note 3.)	Over Operating Range	–	20	50	mV
Short Circuit Current	V_{REF} = 0, T_A = 25°C	–	80	100	mA
Output Noise Voltage (Note 3.)	10 Hz ≤ f ≤ 10 kHz, T_A = 25°C	–	40	–	μV_{RMS}
Long Term Stability (Note 3.)	T_A = 125°C, 1000 Hrs.	–	20	50	mV
Oscillator Section	**R_T = 2700 Ω, C_T = 0.01 μF; unless otherwise specified**				
Initial Accuracy	T_A = 25°C	39	43	47	kHz
Temperature Stability (Note 3.)	Over Operating Temperature Range	–	1.0	2.0	%
Minimum Frequency	R_T = 150 kΩ, C_T = 0.1 μF	–	–	120	Hz
Maximum Frequency	R_T = 2.0 kΩ, C_T = 470 pF	500	–	–	kHz
Output Amplitude (Note 3.)	T_A = 25°C	–	3.5	–	V
Output Pulse Width (Note 3.)	T_A = 25°C	–	0.5	–	μs
Ramp Peak	–	3.3	3.5	3.7	V
Ramp Valley	–	0.7	0.9	1.0	V
Error Amplifier Section	**V_{CM} = 2.5 V; unless otherwise specified**				
Input Offset Voltage	–	–	2.0	10	mV
Input Bias Current	–	–	1.0	10	μA
Input Offset Current	–	–	0.5	1.0	μA
Common Mode Rejection Ratio	V_{CM} = 1.5 to 5.5 V	60	75	–	dB
Power Supply Rejection Ratio	V_{IN} = 10 to 40 V	50	60	–	dB
Output Swing	Minimum Total Range	0.5	–	5.0	V
Open Loop Voltage Gain	ΔV_{OUT} = 1.0 to 4.0 V, R_L ≥ 10 MΩ	60	80	–	dB
Gain–Bandwidth (Note 3.)	T_A = 25°C, A_V = 0 dB	–	3.0	–	MHz
Current Limit Amplifier	**V_{SENSE} = V_O; unless otherwise specified**				
Input Offset Voltage	T_A = 25°C, EA Set for Max. Output	180	200	220	mV
Input Offset Voltage	Over Operating Temperature Range	170	–	230	mV
Input Bias Current	–	–	–1.0	–10	μA
Common Mode Rejection Ratio	V_{SENSE} = 0 to 15 V	50	60	–	dB
Power Supply Rejection Ratio	V_{IN} = 10 to 40 V	50	60	–	dB

3. These parameters are guaranteed by design but not 100% tested in production.

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ELECTRICAL CHARACTERISTICS (continued) ($0°C \leq T_A \leq +70°C$, $V_{IN} = V_{CC} = 20$ V; unless otherwise specified.)

Characteristic	Test Conditions	Min	Typ	Max	Unit
Current Limit Amplifier (continued)	$V_{SENSE} = V_O$; unless otherwise specified				
Output Swing	Minimum Total Range	0.5	–	5.0	V
Open Loop Voltage Gain	$\Delta V_{OUT} = 1.0$ to 4.0 V, $R_L \geq 10$ MΩ	70	80	–	dB
Delay Time (Note 4.)	$\Delta V_{IN} = 300$ mV	–	300	–	ns
Output Section (Each Output)					
Collector Emitter Voltage	$I_C = 100$ µA	60	80	–	V
Collector Leakage Current	$V_{CE} = 50$ V	–	0.1	20	µA
Saturation	$I_C = 20$ mA $I_C = 200$ mA	– –	0.2 1.0	0.4 2.2	V V
Emitter Output Voltage	$I_E = 50$ mA	17	18	–	V
Rise Time (Note 4.)	$T_A = 25°C$, R = 2.0 kΩ	–	200	–	ns
Fall Time (Note 4.)	$T_A = 25°C$, R = 2.0 kΩ	–	100	–	ns
Comparator Delay (Note 4.)	$T_A = 25°C$, V_{COMP} to V_{OUT}	–	300	–	ns
Shutdown Delay (Note 4.)	$T_A = 25°C$, V_{SHUT} to V_{OUT}	–	200	–	ns
Shutdown Threshold	$T_A = 25°C$, $R_C = 2.0$ kΩ	0.5	0.7	1.0	V
Thermal Shutdown (Note 4.)	–	–	165	–	°C

4. These parameters are guaranteed by design but not 100% tested in production.

TYPICAL PERFORMANCE CHARACTERISTICS
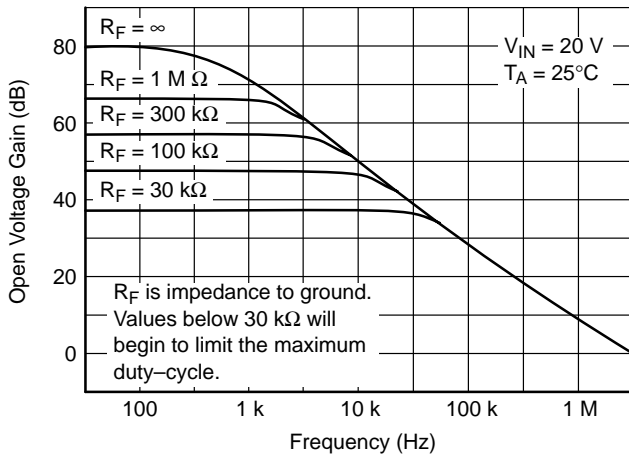
Figure 2. Error Amplifier Voltage Gain vs. Frequency Over RF
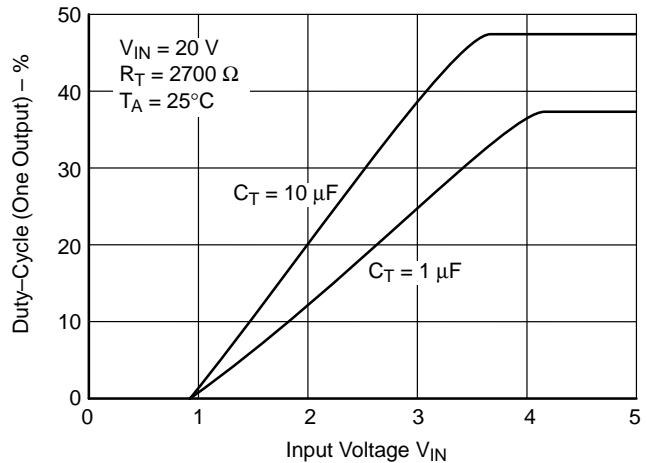
Figure 3. Duty Cycle vs. Input Voltage
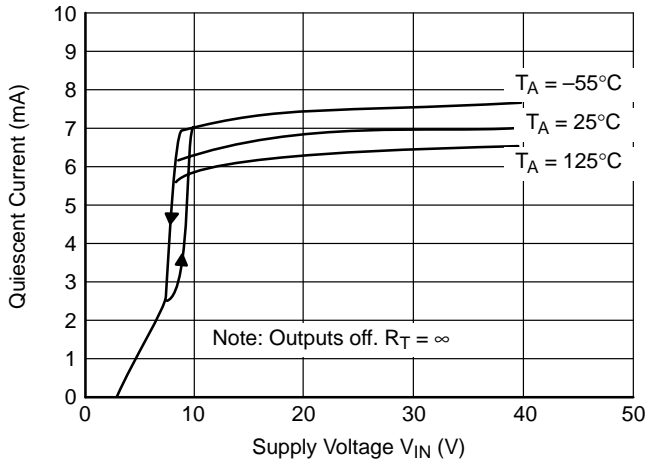
Figure 4. Quiescent Supply Current vs. Supply Voltage Over Temperature
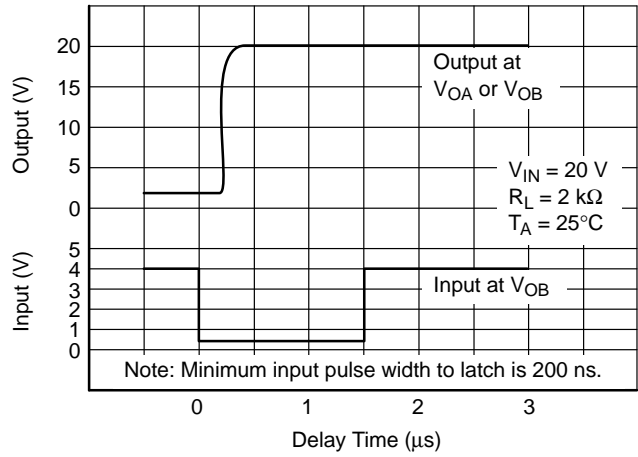
Figure 5. Shutdown Delay from PWM Comparator
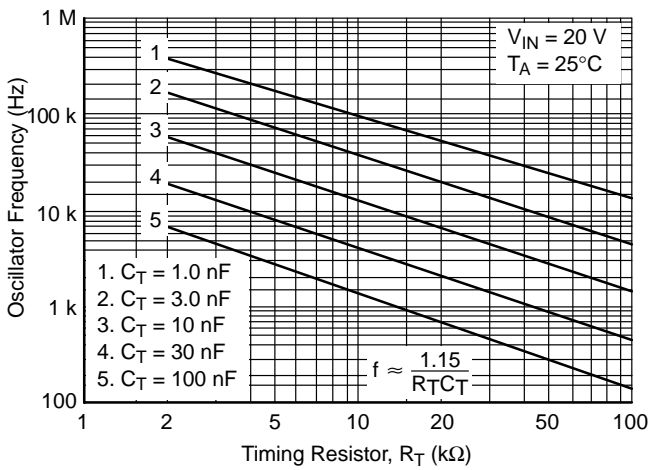
Figure 6. Oscillator Frequency vs. Timing Components Resistor Over Timing Capacitance
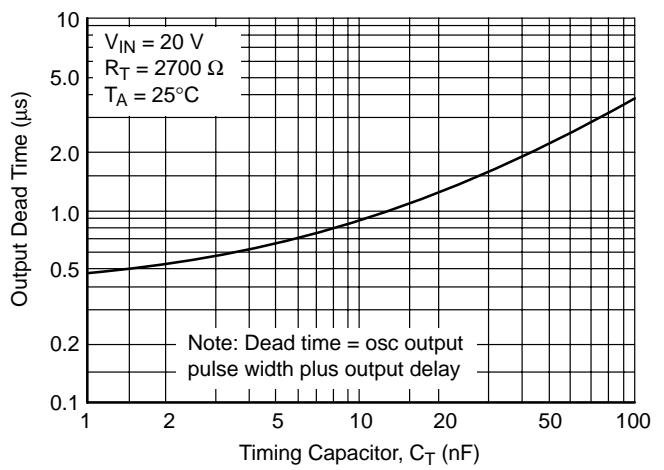
Figure 7. Output Dead Time vs. Timing Capacitor Value
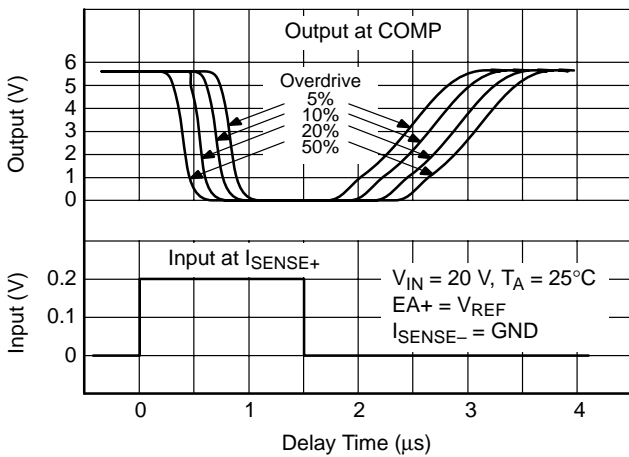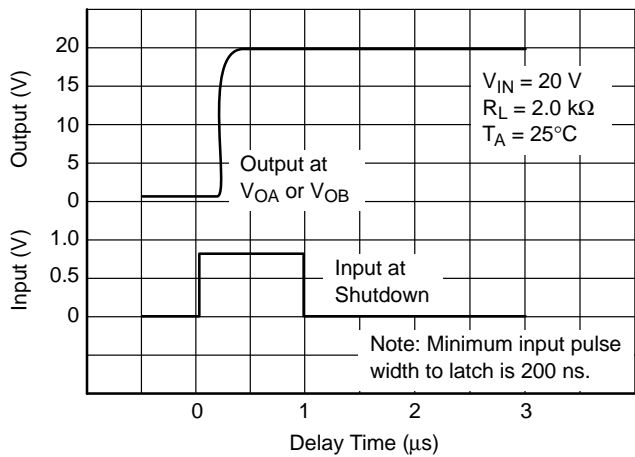

Figure 8. Current Limit Amplifier Delay

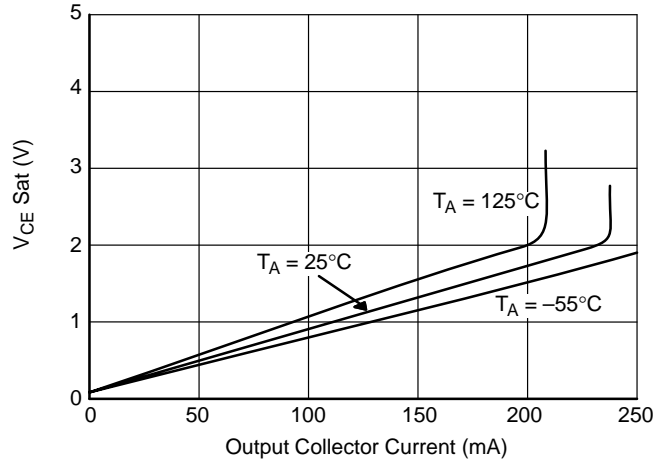**Figure 9. Turn–Off Delay from Shutdown**

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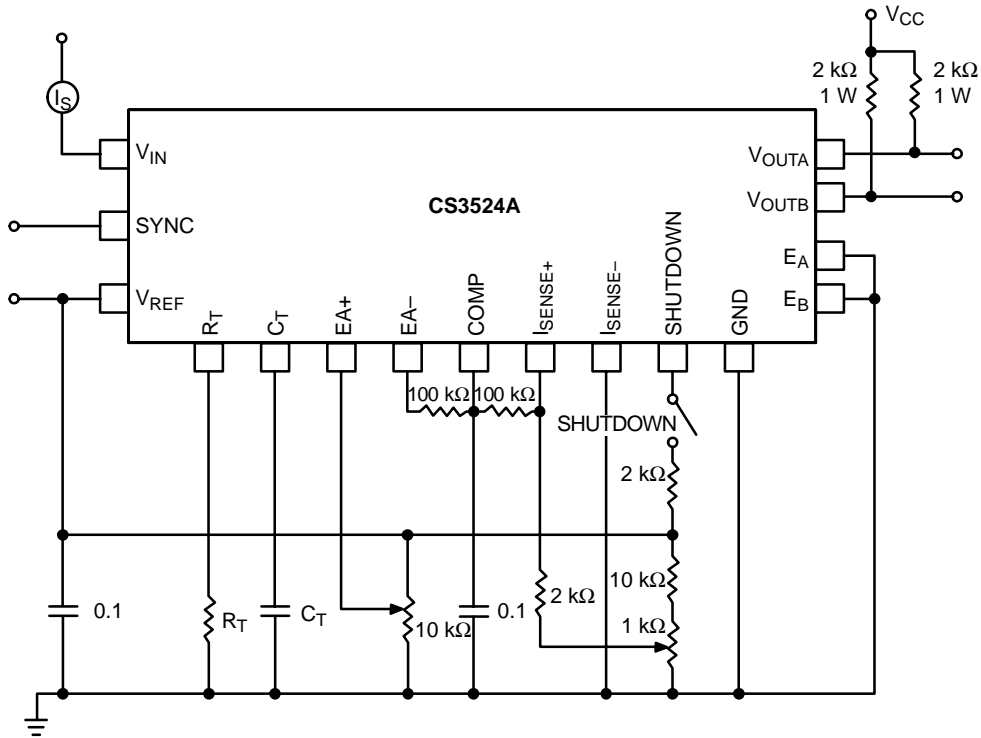**Figure 10. Output Saturation Voltage vs. Output
Current Over Temperature**

Figure 11. Open Loop Test Circuit

Note: The CS3524A should be able to be tested in any 3524 test circuit with two possible exceptions:

1. The higher gain–bandwidth of the current limit amplifier in the CS3524A may cause oscillations in an uncompensated 3524 test circuit.

2. The effect of the shutdown cannot be seen at the compensation terminal, but must be observed at the outputs.

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PACKAGE DIMENSIONS

DIP–16
N SUFFIX
CASE 648–08
ISSUE R
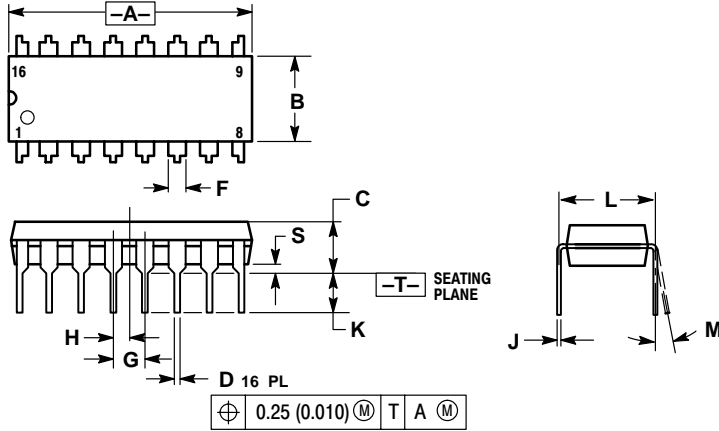
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL

DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.740	0.770	18.80	19.55
B	0.250	0.270	6.35	6.85
C	0.145	0.175	3.69	4.44
D	0.015	0.021	0.39	0.53
F	0.040	0.70	1.02	1.77
G	0.100 BSC		2.54 BSC	
H	0.050 BSC		1.27 BSC	
J	0.008	0.015	0.21	0.38
K	0.110	0.130	2.80	3.30
L	0.295	0.305	7.50	7.74
M	0 °	10 °	0 °	10 °
S	0.020	0.040	0.51	1.01

SO–16L
DW SUFFIX
CASE 751G–03
ISSUE B
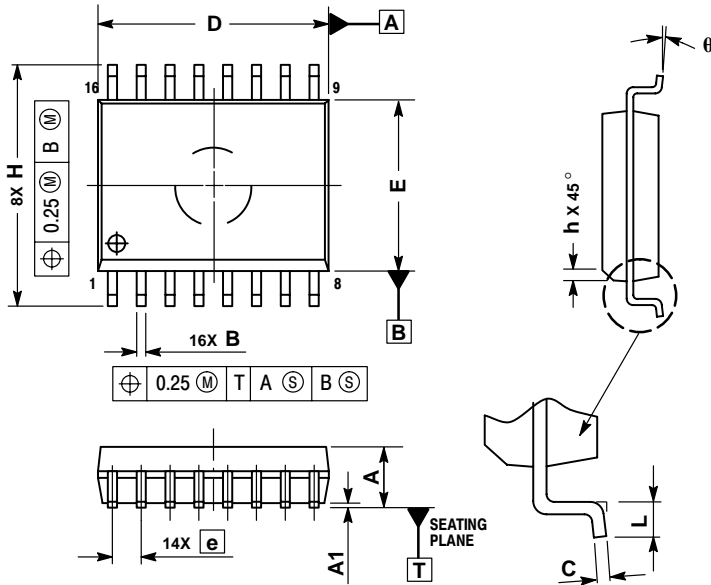
NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSIONS D AND E DO NOT INLCUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS MIN	MILLIMETERS MAX
A	2.35	2.65
A1	0.10	0.25
B	0.35	0.49
C	0.23	0.32
D	10.15	10.45
E	7.40	7.60
e	1.27 BSC	
H	10.05	10.55
h	0.25	0.75
L	0.50	0.90
θ	0 °	7 °

PACKAGE THERMAL DATA

Parameter		DIP–16	SO–16L	Unit
R$_{\Theta JC}$	Typical	42	23	°C/W
R$_{\Theta JA}$	Typical	80	105	°C/W

PUBLICATION ORDERING INFORMATION