

MC34060A, MC33060A

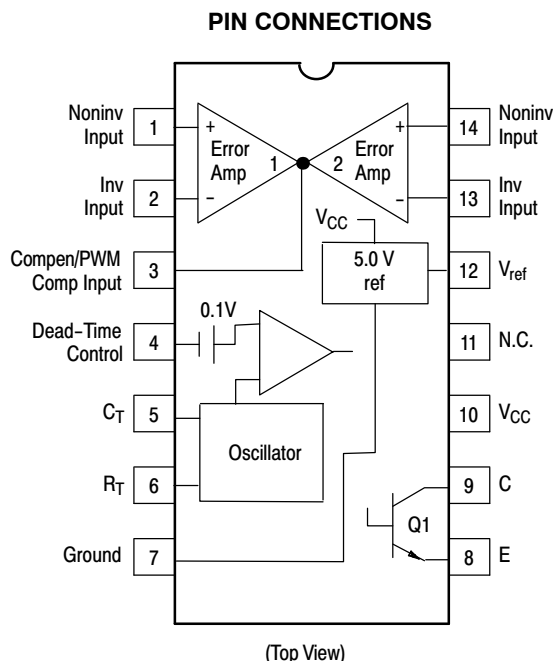
Fixed Frequency, PWM, Voltage Mode Single Ended Controllers

The MC34060A is a low cost fixed frequency, pulse width modulation control circuit designed primarily for single-ended SWITCHMODE™ power supply control.

The MC34060A is specified over the commercial operating temperature range of 0° to +70°C, and the MC33060A is specified over an automotive temperature range of -40° to +85°C.

Features

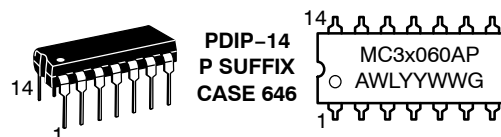
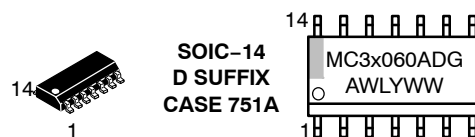
- Complete Pulse Width Modulation Control Circuitry
- On-Chip Oscillator with Master or Slave Operation
- On-Chip Error Amplifiers
- On-Chip 5.0 V Reference, 1.5% Accuracy
- Adjustable Dead-Time Control
- Uncommitted Output Transistor Rated to 200 mA Source or Sink
- Undervoltage Lockout
- These are Pb-Free and Halide-Free Devices



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MARKING DIAGRAMS



x = 3 or 4
A = Assembly Location
WL = Wafer Lot
Y, YY = Year
WW = Work Week
G = Pb-Free Package

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 14 of this data sheet.

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MAXIMUM RATINGS (Full operating ambient temperature range applies, unless otherwise noted.)

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	42	V
Collector Output Voltage	V_C	42	V
Collector Output Current (Note 3)	I_C	500	mA
Amplifier Input Voltage Range	V_{in}	-0.3 to +42	V
Power Dissipation @ $T_A \leq 45^\circ\text{C}$	P_D	1000	mW
Operating Junction Temperature	T_J	125	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-55 to +125	$^\circ\text{C}$
Operating Ambient Temperature Range For MC34060A For MC33060A	T_A	0 to +70 -40 to +85	$^\circ\text{C}$
ESD Capability Machine Model Human Body Model		200 2.0	V kV

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

- This device series contains ESD protection and exceeds the following tests:
Pins 1– 14: Human Body Model 2000 V per JEDEC Standard JESD22-A114E.
Machine Model Method 200 V per JEDEC Standard JESD22-A115-A.
- This device contains Latch-Up protection and exceeds ± 100 mA per JEDEC Standard JESD78.

THERMAL CHARACTERISTICS

Characteristics	Symbol	P Suffix Package	D Suffix Package	Unit
Thermal Resistance, Junction-to-Ambient	$R_{\theta JA}$	80	120	$^\circ\text{C}/\text{W}$
Derating Ambient Temperature	T_A	45	45	$^\circ\text{C}$

RECOMMENDED OPERATING CONDITIONS

Condition/Value	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V_{CC}	7.0	15	40	V
Collector Output Voltage	V_C	–	30	40	V
Collector Output Current	I_C	–	–	200	mA
Amplifier Input Voltage	V_{in}	-0.3	–	$V_{CC} - 2$	V
Current Into Feedback Terminal	I_{fb}	–	–	0.3	mA
Reference Output Current	I_{ref}	–	–	10	mA
Timing Resistor	R_T	1.8	47	500	$k\Omega$
Timing Capacitor	C_T	0.00047	0.001	10	μF
Oscillator Frequency	f_{osc}	1.0	25	200	kHz
PWM Input Voltage (Pins 3 and 4)	–	-0.3	–	5.3	V

- Maximum thermal limits must be observed.

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ELECTRICAL CHARACTERISTICS ($V_{CC} = 15\text{ V}$, $C_T = 0.01\text{ }\mu\text{F}$, $R_T = 12\text{ k}\Omega$, unless otherwise noted. For typical values $T_A = 25^\circ\text{C}$, for min/max values T_A is the operating ambient temperature range that applies, unless otherwise noted.)

Characteristics	Symbol	Min	Typ	Max	Unit
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REFERENCE SECTION

Reference Voltage ($I_O = 1.0\text{ mA}$, $T_A = 25^\circ\text{C}$) $T_A = T_{\text{low}}$ to T_{high} – MC34060A – MC33060A	V_{ref}	4.925 4.9 4.85	5.0 – –	5.075 5.1 5.1	V
Line Regulation ($V_{CC} = 7.0\text{ V}$ to 40 V , $I_O = 10\text{ mA}$)	Reg_{line}	–	2.0	25	mV
Load Regulation ($I_O = 1.0\text{ mA}$ to 10 mA)	Reg_{load}	–	2.0	15	mV
Short Circuit Output Current ($V_{\text{ref}} = 0\text{ V}$)	I_{SC}	15	35	75	mA

OUTPUT SECTION

Collector Off-State Current ($V_{CC} = 40\text{ V}$, $V_{CE} = 40\text{ V}$)	$I_{C(\text{off})}$	–	2.0	100	μA
Emitter Off-State Current ($V_{CC} = 40\text{ V}$, $V_{CE} = 40\text{ V}$, $V_E = 0\text{ V}$)	$I_{E(\text{off})}$	–	–	–100	μA
Collector-Emitter Saturation Voltage (Note 4) Common-Emitter ($V_E = 0\text{ V}$, $I_C = 200\text{ mA}$) Emitter-Follower ($V_C = 15\text{ V}$, $I_E = -200\text{ mA}$)	$V_{\text{sat}(C)}$ $V_{\text{sat}(E)}$	– –	1.1 1.5	1.5 2.5	V
Output Voltage Rise Time ($T_A = 25^\circ\text{C}$) Common-Emitter (See Figure 12) Emitter-Follower (See Figure 13)	t_r	– –	100 100	200 200	ns
Output Voltage Fall Time ($T_A = 25^\circ\text{C}$) Common-Emitter (See Figure 12) Emitter-Follower (See Figure 13)	t_f	– –	40 40	100 100	ns

ERROR AMPLIFIER SECTION

Input Offset Voltage ($V_{O[\text{Pin } 3]} = 2.5\text{ V}$)	V_{IO}	–	2.0	10	mV
Input Offset Current ($V_{C[\text{Pin } 3]} = 2.5\text{ V}$)	I_{IO}	–	5.0	250	nA
Input Bias Current ($V_{O[\text{Pin } 3]} = 2.5\text{ V}$)	I_{IB}	–	–0.1	–2.0	μA
Input Common Mode Voltage Range ($V_{CC} = 40\text{ V}$)	V_{ICR}	0 to $V_{CC} - 2.0$	–	–	V
Inverting Input Voltage Range	$V_{IR(\text{INV})}$	–0.3 to $V_{CC} - 2.0$	–	–	V
Open-Loop Voltage Gain ($\Delta V_O = 3.0\text{ V}$, $V_O = 0.5\text{ V}$ to 3.5 V , $R_L = 2.0\text{ k}\Omega$)	A_{VOL}	70	95	–	dB
Unity-Gain Crossover Frequency ($V_O = 0.5\text{ V}$ to 3.5 V , $R_L = 2.0\text{ k}\Omega$)	f_c	–	600	–	kHz
Phase Margin at Unity-Gain ($V_O = 0.5\text{ V}$ to 3.5 V , $R_L = 2.0\text{ k}\Omega$)	ϕ_m	–	65	–	deg.
Common Mode Rejection Ratio ($V_{CC} = 40\text{ V}$, $V_{in} = 0\text{ V}$ to 38 V)	CMRR	65	90	–	dB
Power Supply Rejection Ratio ($\Delta V_{CC} = 33\text{ V}$, $V_O = 2.5\text{ V}$, $R_L = 2.0\text{ k}\Omega$)	PSRR	–	100	–	dB
Output Sink Current ($V_{O[\text{Pin } 3]} = 0.7\text{ V}$)	I_{O-}	0.3	0.7	–	mA
Output Source Current ($V_{O[\text{Pin } 3]} = 3.5\text{ V}$)	I_{O+}	–2.0	–4.0	–	mA

4. Low duty cycle techniques are used during test to maintain junction temperature as close to ambient temperatures as possible.

$T_{\text{low}} = -40^\circ\text{C}$ for MC33060A
= 0°C for MC34060A

$T_{\text{high}} = +85^\circ\text{C}$ for MC33060A
= $+70^\circ\text{C}$ for MC34060A

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ELECTRICAL CHARACTERISTICS (continued) ($V_{CC} = 15\text{ V}$, $C_T = 0.01\text{ }\mu\text{F}$, $R_T = 12\text{ k}\Omega$, unless otherwise noted.)

For typical values $T_A = 25^\circ\text{C}$, for min/max values T_A is the operating ambient temperature range that applies, unless otherwise noted.)

Characteristics	Symbol	Min	Typ	Max	Unit
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PWM COMPARATOR SECTION (Test circuit Figure 11)

Input Threshold Voltage (Zero Duty Cycle)	V_{TH}	–	3.5	4.5	V
Input Sink Current ($V_{Pin\ 3} = 0.7\text{ V}$)	I_I	0.3	0.7	–	mA

DEAD-TIME CONTROL SECTION (Test circuit Figure 11)

Input Bias Current (Pin 4) ($V_{in} = 0\text{ V}$ to 5.25 V)	$I_{IB(DT)}$	–	–1.0	–10	μA
Maximum Output Duty Cycle ($V_{in} = 0\text{ V}$, $C_T = 0.01\text{ }\mu\text{F}$, $R_T = 12\text{ k}\Omega$) ($V_{in} = 0\text{ V}$, $C_T = 0.001\text{ }\mu\text{F}$, $R_T = 47\text{ k}\Omega$)	DC_{max}	90 –	96 92	100 –	%
Input Threshold Voltage (Pin 4) (Zero Duty Cycle) (Maximum Duty Cycle)	V_{TH}	– 0	2.8 –	3.3 –	V

OSCILLATOR SECTION

Frequency ($C_T = 0.01\text{ }\mu\text{F}$, $R_T = 12\text{ k}\Omega$, $T_A = 25^\circ\text{C}$) $T_A = T_{low}$ to T_{high} – MC34060A – MC33060A ($C_T = 0.001\text{ }\mu\text{F}$, $R_T = 47\text{ k}\Omega$)	f_{osc}	9.7 9.5 9.0 –	10.5 – – 25	11.3 11.5 11.5 –	kHz
Standard Deviation of Frequency* ($C_T = 0.001\text{ }\mu\text{F}$, $R_T = 47\text{ k}\Omega$)	σf_{osc}	–	1.5	–	%
Frequency Change with Voltage ($V_{CC} = 7.0\text{ V}$ to 40 V)	$\Delta f_{osc}(\Delta V)$	–	0.5	2.0	%
Frequency Change with Temperature ($\Delta T_A = T_{low}$ to T_{high}) ($C_T = 0.01\text{ }\mu\text{F}$, $R_T = 12\text{ k}\Omega$)	$\Delta f_{osc}(\Delta T)$	– –	4.0 –	– –	%

UNDERVOLTAGE LOCKOUT SECTION

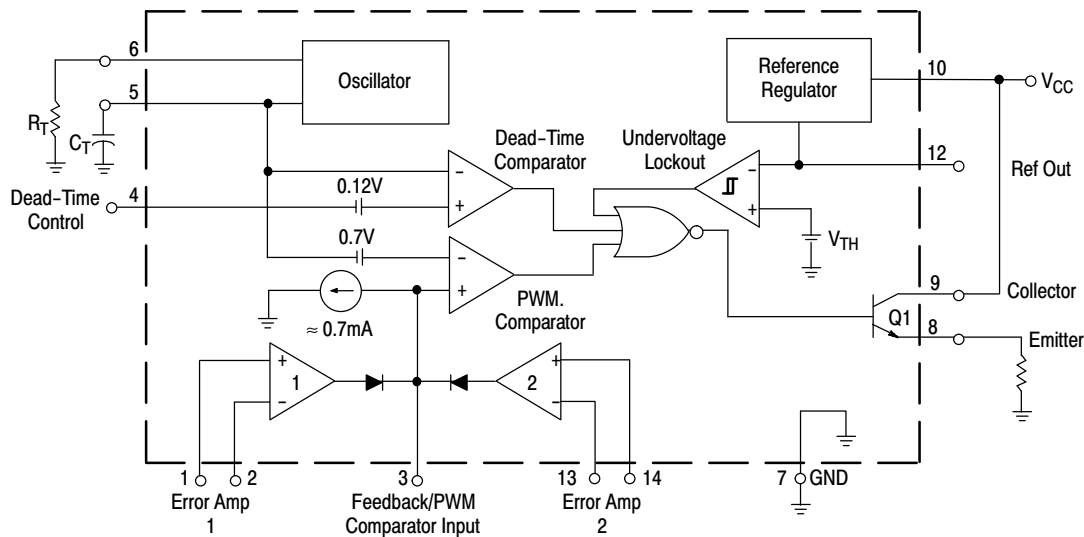
Turn-On Threshold (V_{CC} increasing, $I_{ref} = 1.0\text{ mA}$)	V_{th}	4.0	4.7	5.5	V
Hysteresis	V_H	50	150	300	mV

TOTAL DEVICE

Standby Supply Current (Pin 6 at V_{ref} , all other inputs and outputs open) ($V_{CC} = 15\text{ V}$) ($V_{CC} = 40\text{ V}$)	I_{CC}	– –	5.5 7.0	10 15	mA
Average Supply Current ($V_{Pin\ 4} = 2.0\text{ V}$, $C_T = 0.001\text{ }\mu\text{F}$, $R_T = 47\text{ k}\Omega$). See Figure 11.	I_S	–	7.0	–	mA

*Standard deviation is a measure of the statistical distribution about the mean as derived from the formula; $\sigma = \sqrt{\frac{\sum_{n=1}^N (x_n - \bar{x})^2}{N-1}}$

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This device contains 46 active transistors.

Figure 1. Block Diagram

Description

The MC34060A is a fixed-frequency pulse width modulation control circuit, incorporating the primary building blocks required for the control of a switching power supply (see Figure 1). An internal-linear sawtooth oscillator is frequency-programmable by two external components, R_T and C_T . The approximate oscillator frequency is determined by:

$$f_{osc} \cong \frac{1.2}{R_T \cdot C_T}$$

For more information refer to Figure 3.

Output pulse width modulation is accomplished by comparison of the positive sawtooth waveform across capacitor C_T to either of two control signals. The output is enabled only during that portion of time when the sawtooth voltage is greater than the control signals. Therefore, an increase in control-signal amplitude causes a corresponding linear decrease of output pulse width. (Refer to the Timing Diagram shown in Figure 2.)

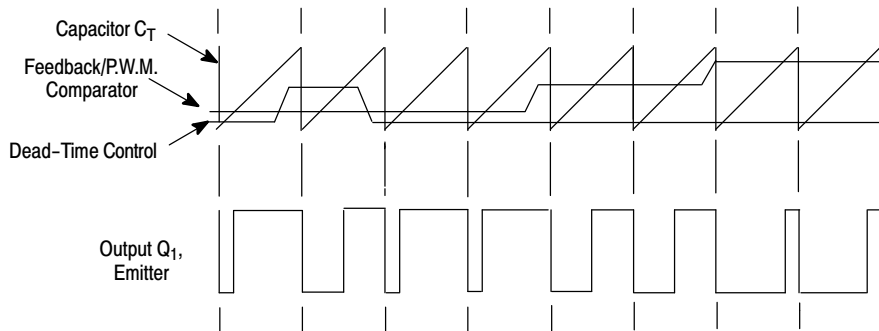


Figure 2. Timing Diagram

APPLICATIONS INFORMATION

The control signals are external inputs that can be fed into the dead-time control, the error amplifier inputs, or the feed-back input. The dead-time control comparator has an effective 120 mV input offset which limits the minimum output dead time to approximately the first 4% of the sawtooth-cycle time. This would result in a maximum duty cycle of 96%. Additional dead time may be imposed on the output by setting the dead time-control input to a fixed voltage, ranging between 0 V to 3.3 V.

The pulse width modulator comparator provides a means for the error amplifiers to adjust the output pulse width from the maximum percent on-time, established by the dead time control input, down to zero, as the voltage at the feedback

pin varies from 0.5 V to 3.5 V. Both error amplifiers have a common mode input range from -0.3 V to $(V_{CC} - 2.0)$ V, and may be used to sense power supply output voltage and current. The error-amplifier outputs are active high and are ORed together at the noninverting input of the pulse-width modulator comparator. With this configuration, the amplifier that demands minimum output on time, dominates control of the loop.

The MC34060A has an internal 5.0 V reference capable of sourcing up to 10 mA of load currents for external bias circuits. The reference has an internal accuracy of $\pm 5\%$ with a typical thermal drift of less than 50 mV over an operating temperature range of 0° to $+70^{\circ}\text{C}$.

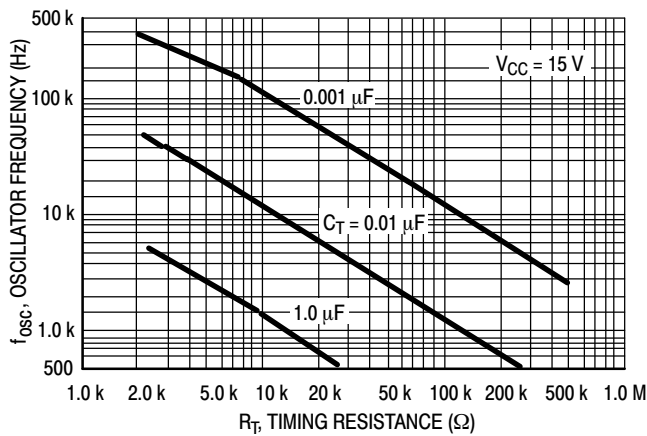


Figure 3. Oscillator Frequency versus Timing Resistance

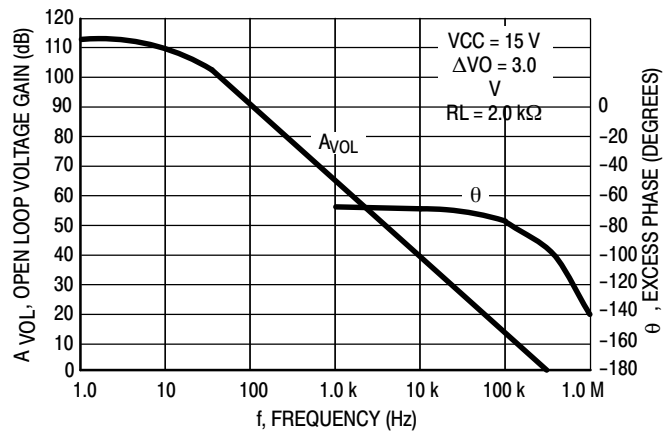


Figure 4. Open Loop Voltage Gain and Phase versus Frequency

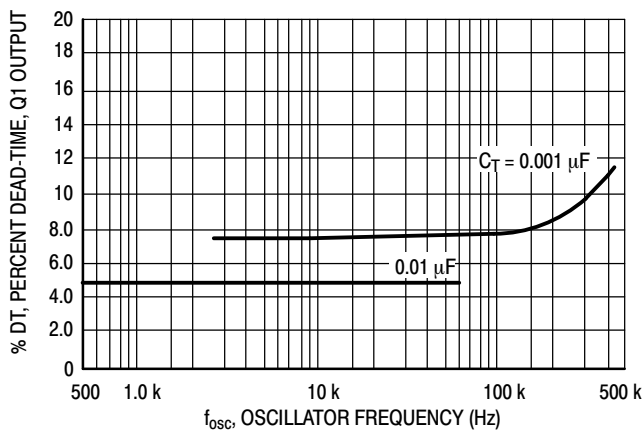


Figure 5. Percent Deadtime versus Oscillator Frequency

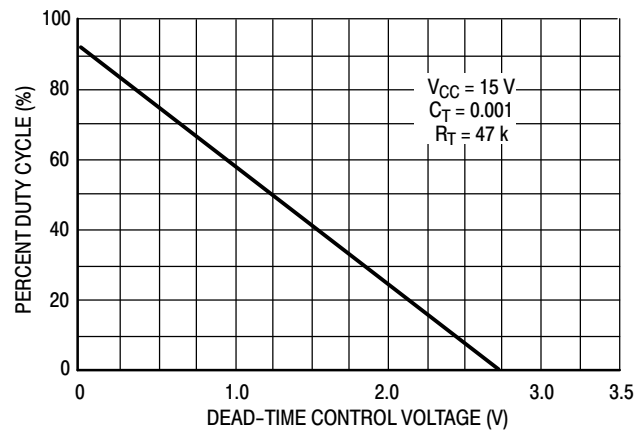
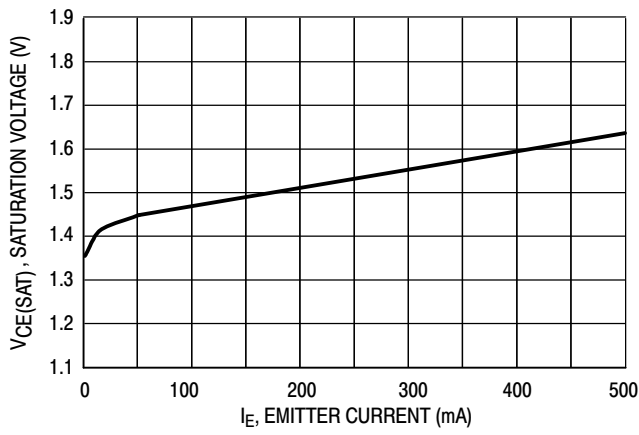
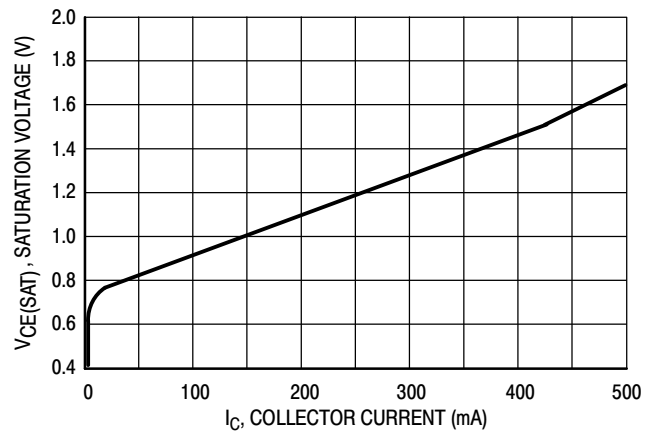


Figure 6. Percent Duty Cycle versus Dead-Time Control Voltage

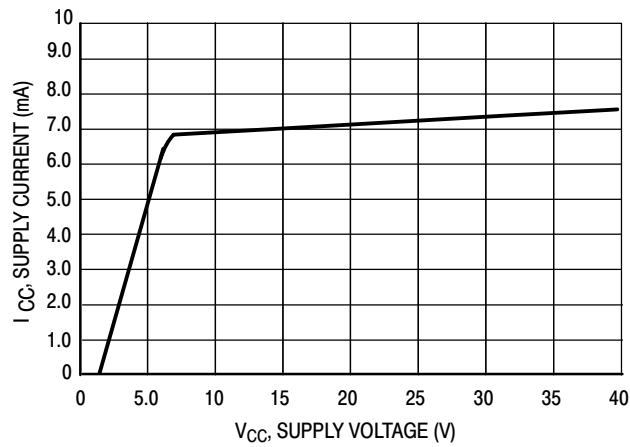
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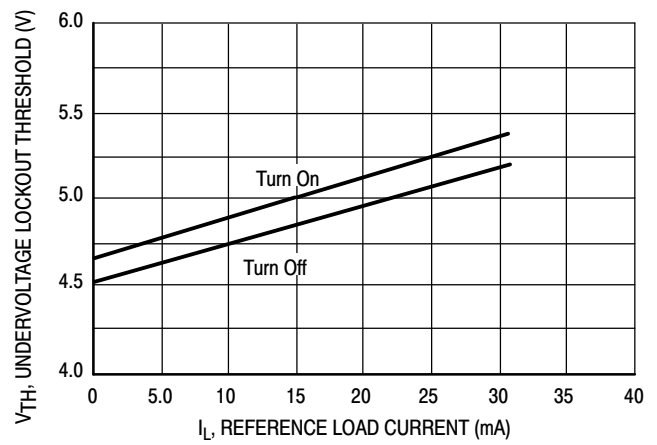
**Figure 7. Emitter-Follower Configuration
Output Saturation Voltage versus
Emitter Current**



**Figure 8. Common-Emitter Configuration
Output Saturation Voltage versus
Collector Current**



**Figure 9. Standby Supply Current
versus Supply Voltage**



**Figure 10. Undervoltage Lockout Thresholds
versus Reference Load Current**

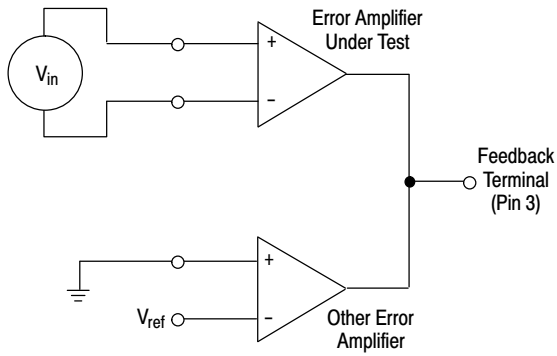


Figure 11. Error Amplifier Characteristics

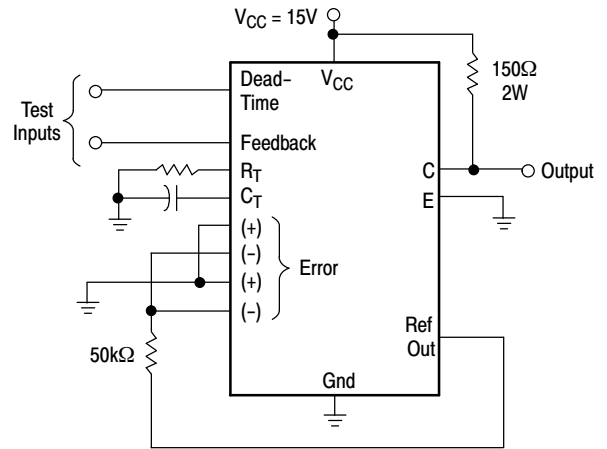


Figure 12. Deadtime and Feedback Control

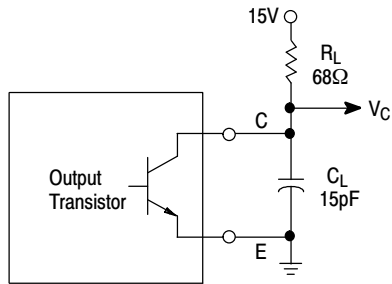


Figure 13. Common-Emitter Configuration and Waveform

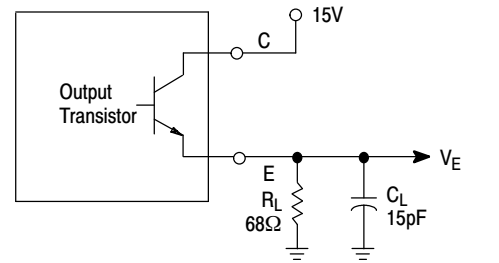


Figure 14. Emitter-Follower Configuration and Waveform

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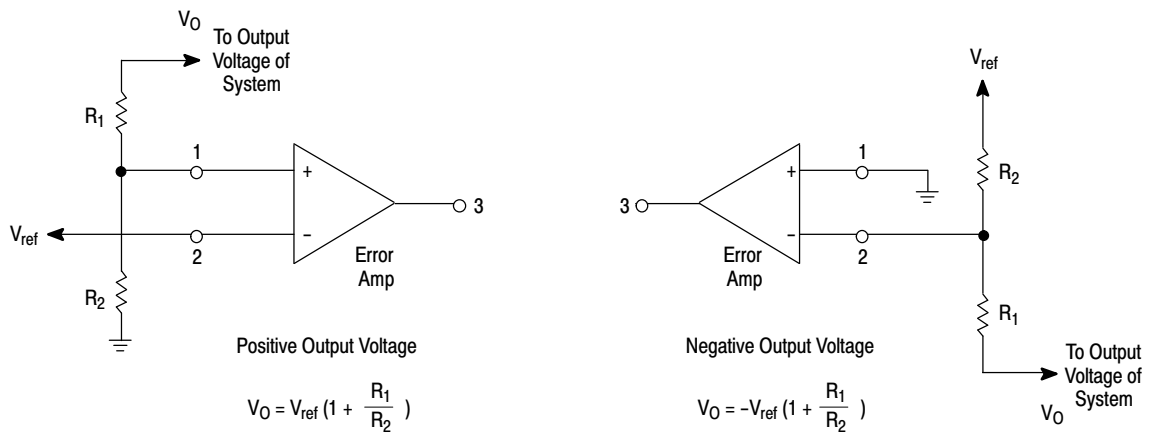


Figure 15. Error Amplifier Sensing Techniques

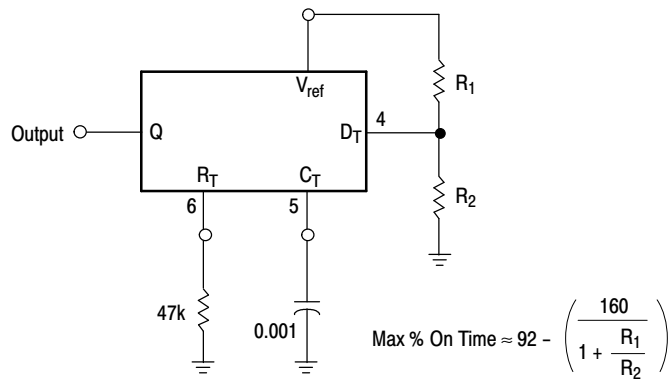


Figure 16. Deadtime Control Circuit

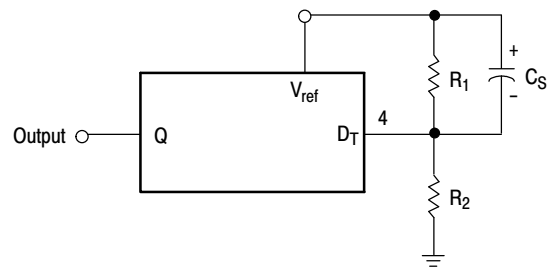


Figure 17. Soft-Start Circuit

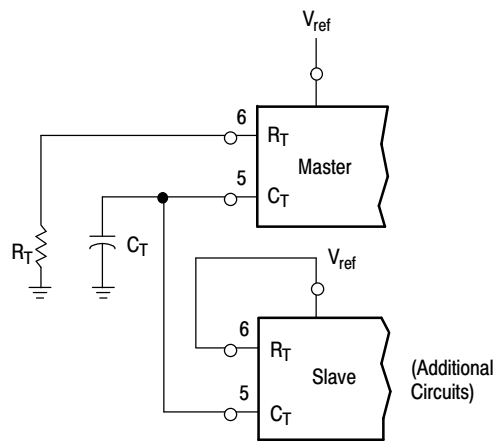
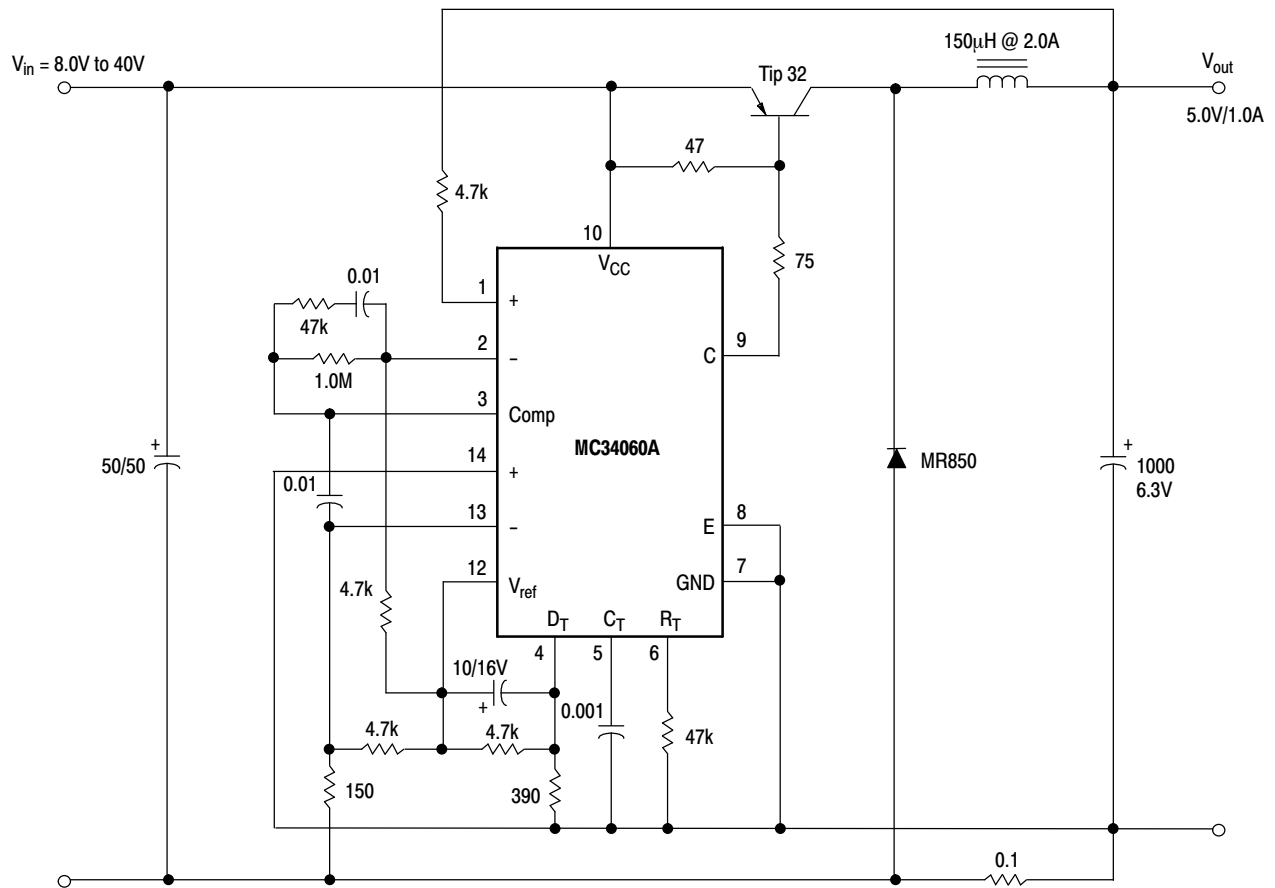


Figure 18. Slaving Two or More Control Circuits

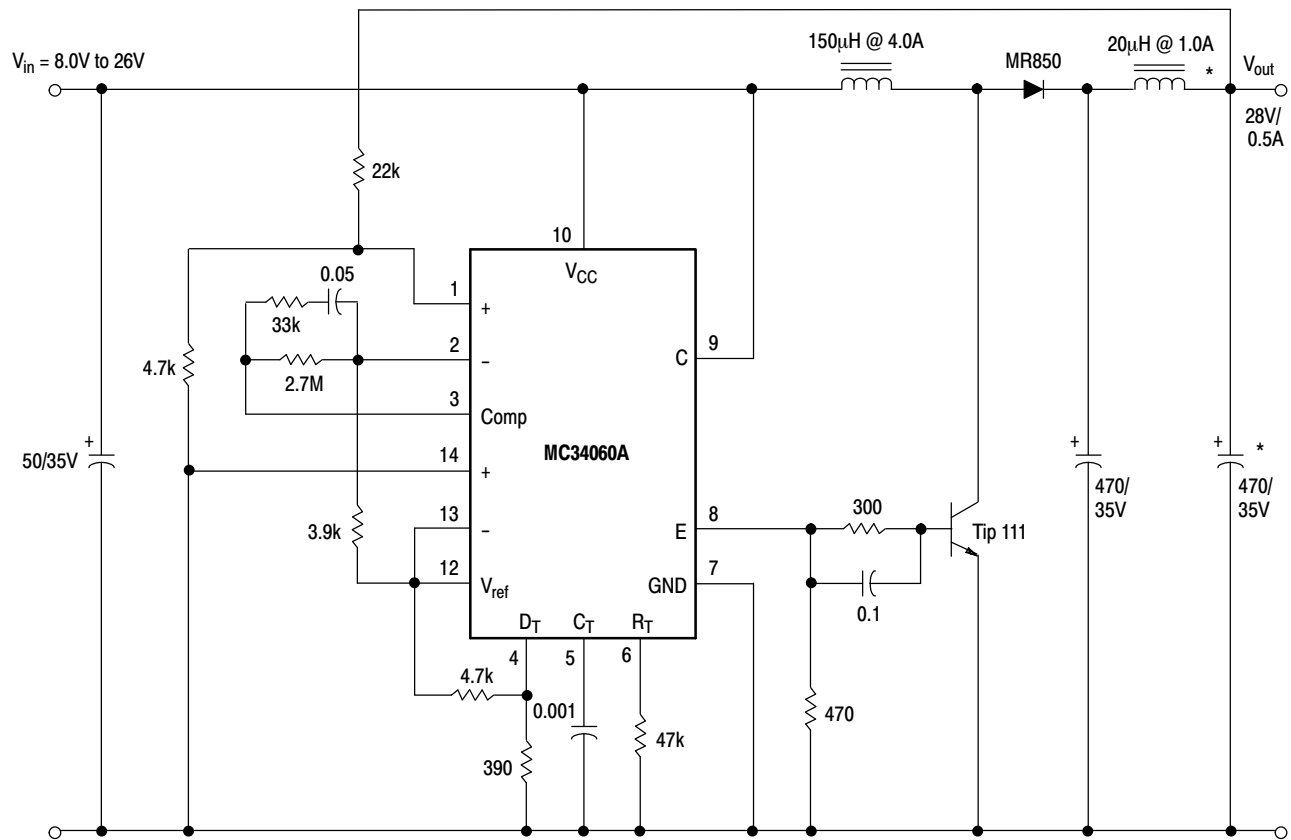
MC34060A, MC33060A



Test	Conditions	Results
Line Regulation	$V_{in} = 8.0 \text{ V to } 40 \text{ V}$, $I_O = 1.0 \text{ A}$	25 mV 0.5%
Load Regulation	$V_{in} = 12 \text{ V}$, $I_O = 1.0 \text{ mA to } 1.0 \text{ A}$	3.0 mV 0.06%
Output Ripple	$V_{in} = 12 \text{ V}$, $I_O = 1.0 \text{ A}$	75 mV p-p P.A.R.D.
Short Circuit Current	$V_{in} = 12 \text{ V}$, $R_L = 0.1 \Omega$	1.6 A
Efficiency	$V_{in} = 12 \text{ V}$, $I_O = 1.0 \text{ A}$	73%

Figure 19. Step-Down Converter with Soft-Start and Output Current Limiting

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Test	Conditions	Results
Line Regulation	$V_{in} = 8.0 \text{ V to } 26 \text{ V}, I_O = 0.5 \text{ A}$	40 mV 0.14%
Load Regulation	$V_{in} = 12 \text{ V}, I_O = 1.0 \text{ mA to } 0.5 \text{ A}$	5.0 mV 0.18%
Output Ripple	$V_{in} = 12 \text{ V}, I_O = 0.5 \text{ A}$	24 mV p-p P.A.R.D.
Efficiency	$V_{in} = 12 \text{ V}, I_O = 0.5 \text{ A}$	75%

*Optional circuit to minimize output ripple

Figure 20. Step-Up Converter

The circuit diagram shows a precision current source using the MC34060A. The input voltage V_{in} is 8.0V to 40V. The output voltage V_{out} is -15V/0.25A. The circuit includes a 50/50V transformer, a 7.5k resistor, a 30k resistor, a 47k resistor, a 1.0M resistor, a 0.01 capacitor, a 10k resistor, a 10/16V capacitor, a 47k resistor, a 4.7k resistor, a 0.001 capacitor, a 47k resistor, a 3.3k resistor, a 820 resistor, a 150μH inductor, a 330/16V capacitor, a 1.0 resistor, a Tip 32C transistor, and an MR851 diode. The MC34060A is configured with pins 1, 2, 3, 14, 13, 12, 4, 5, 6, 8, 7, 9, 10, and 11 connected to various components and ground.

*Optional circuit to minimize output ripple

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Figure 22. 33 W Off-Line Flyback Converter with Soft-Start and Primary Power Limiting

Test	Conditions	Results
Line Regulation 5.0 V	$V_{in} = 95 \text{ Vac}$ to 135 Vac, $I_O = 3.0 \text{ A}$	20 mV
Line Regulation $\pm 12 \text{ V}$	$V_{in} = 95 \text{ Vac}$ to 135 Vac, $I_O = \pm 0.75 \text{ A}$	0.40%
Load Regulation 5.0 V	$V_{in} = 115 \text{ Vac}$, $I_O = 1.0 \text{ A}$ to 4.0 A	52 mV
Load Regulation $\pm 12 \text{ V}$	$V_{in} = 115 \text{ Vac}$, $I_O = \pm 0.4 \text{ A}$ to $\pm 0.9 \text{ A}$	0.26%
Output Ripple 5.0 V	$V_{in} = 115 \text{ Vac}$, $I_O = 3.0 \text{ A}$	476 mV
Output Ripple $\pm 12 \text{ V}$	$V_{in} = 115 \text{ Vac}$, $I_O = \pm 0.75 \text{ A}$	9.5%
Efficiency	$V_{in} = 115 \text{ Vac}$, $I_O 5.0 \text{ V} = 3.0 \text{ A}$ $I_O \pm 12 \text{ V} = \pm 0.75 \text{ A}$	300 mV
		2.5%
		45 mV p-p P.A.R.D.
		75 mV p-p P.A.R.D.
		74%

T1 - Coilcraft W2961

T2 - Core: Coilcraft 11-464-16,
0.025" gap in each leg.

Bobbin: Coilcraft 37-573

Windings:

Primary, 2 each, 75 turns #25 Awg Bifilar wound

Feedback: 15 turns #26 Awg

Secondary, 5.0 V, 6 turns @33 Awg Bifilar wound

Secondary, 3.0 v, 6 turns @ 30 Awg Bifilar wound
Secondary, 2 each, 14 turns #24 Awg Bifilar wound

L1 – Coilcraft Z7156, 15 μ H @ 5.0 A

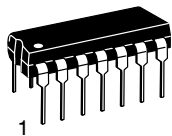
L2, L3 – Coilcraft Z7157, 25 μ H @ 1.0 A

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ORDERING INFORMATION

Device	Operating Temperature Range	Package	Shipping [†]
MC34060ADG	$T_A = 0^\circ \text{ to } +70^\circ\text{C}$	SOIC-14 (Pb-Free)	55 Units / Rail
MC34060ADR2G		SOIC-14 (Pb-Free)	2500 / Tape & Reel
MC34060APG		PDIP-14 (Pb-Free)	25 Units / Rail
MC33060ADG	$T_A = -40^\circ \text{ to } +85^\circ\text{C}$	SOIC-14 (Pb-Free)	55 Units / Rail
MC33060ADR2G		SOIC-14 (Pb-Free)	2500 / Tape & Reel
MC33060APG		PDIP-14 (Pb-Free)	25 Units / Rail

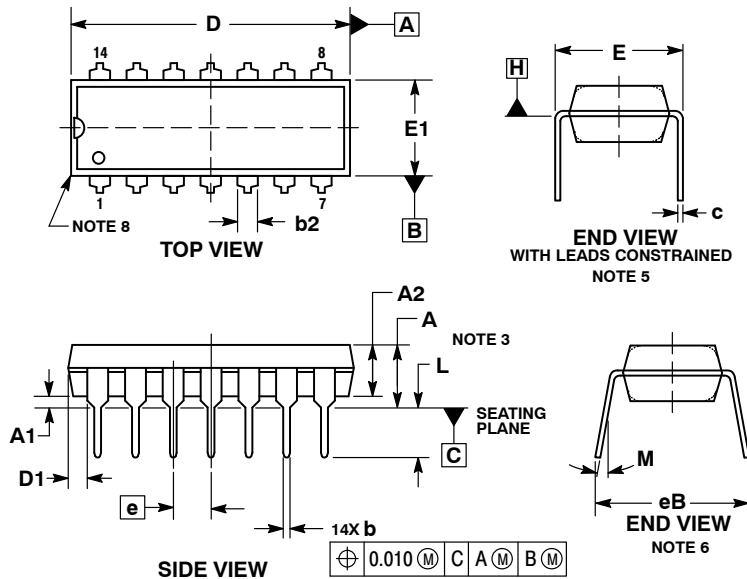
[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



SCALE 1:1

PDIP-14
CASE 646-06
ISSUE S

DATE 22 APR 2015



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSIONS A, A1 AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS-3.
4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 0.10 INCH.
5. DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
6. DIMENSION eB IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
7. DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.
8. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	---	0.210	---	5.33
A1	0.015	---	0.38	---
A2	0.115	0.195	2.92	4.95
b	0.014	0.022	0.35	0.56
b2	0.060 TYP 1.52 TYP			
C	0.008	0.014	0.20	0.36
D	0.735	0.775	18.67	19.69
D1	0.005	---	0.13	---
E	0.300	0.325	7.62	8.26
E1	0.240	0.280	6.10	7.11
e	0.100 BSC		2.54 BSC	
eB	---	0.430	---	10.92
L	0.115	0.150	2.92	3.81
M	---	10°	---	10°

GENERIC
MARKING DIAGRAM*



XXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
YY = Year
WW = Work Week
G = Pb-Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

STYLES ON PAGE 2

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DESCRIPTION:	PDIP-14	PAGE 1 OF 2

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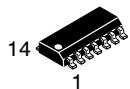
PDIP-14
CASE 646-06
ISSUE S

DATE 22 APR 2015

STYLE 1: PIN 1. COLLECTOR 2. BASE 3. EMITTER 4. NO CONNECTION 5. EMITTER 6. BASE 7. COLLECTOR 8. COLLECTOR 9. BASE 10. EMITTER 11. NO CONNECTION 12. EMITTER 13. BASE 14. COLLECTOR	STYLE 2: CANCELLED	STYLE 3: CANCELLED	STYLE 4: PIN 1. DRAIN 2. SOURCE 3. GATE 4. NO CONNECTION 5. GATE 6. SOURCE 7. DRAIN 8. DRAIN 9. SOURCE 10. GATE 11. NO CONNECTION 12. GATE 13. SOURCE 14. DRAIN
STYLE 5: PIN 1. GATE 2. DRAIN 3. SOURCE 4. NO CONNECTION 5. SOURCE 6. DRAIN 7. GATE 8. GATE 9. DRAIN 10. SOURCE 11. NO CONNECTION 12. SOURCE 13. DRAIN 14. GATE	STYLE 6: PIN 1. COMMON CATHODE 2. ANODE/CATHODE 3. ANODE/CATHODE 4. NO CONNECTION 5. ANODE/CATHODE 6. NO CONNECTION 7. ANODE/CATHODE 8. ANODE/CATHODE 9. ANODE/CATHODE 10. NO CONNECTION 11. ANODE/CATHODE 12. ANODE/CATHODE 13. NO CONNECTION 14. COMMON ANODE	STYLE 7: PIN 1. NO CONNECTION 2. ANODE 3. ANODE 4. NO CONNECTION 5. ANODE 6. NO CONNECTION 7. ANODE 8. ANODE 9. ANODE 10. NO CONNECTION 11. ANODE 12. ANODE 13. NO CONNECTION 14. COMMON CATHODE	STYLE 8: PIN 1. NO CONNECTION 2. CATHODE 3. CATHODE 4. NO CONNECTION 5. CATHODE 6. NO CONNECTION 7. CATHODE 8. CATHODE 9. CATHODE 10. NO CONNECTION 11. CATHODE 12. CATHODE 13. NO CONNECTION 14. COMMON ANODE
STYLE 9: PIN 1. COMMON CATHODE 2. ANODE/CATHODE 3. ANODE/CATHODE 4. NO CONNECTION 5. ANODE/CATHODE 6. ANODE/CATHODE 7. COMMON ANODE 8. COMMON ANODE 9. ANODE/CATHODE 10. ANODE/CATHODE 11. NO CONNECTION 12. ANODE/CATHODE 13. ANODE/CATHODE 14. COMMON CATHODE	STYLE 10: PIN 1. COMMON CATHODE 2. ANODE/CATHODE 3. ANODE/CATHODE 4. ANODE/CATHODE 5. ANODE/CATHODE 6. NO CONNECTION 7. COMMON ANODE 8. COMMON CATHODE 9. ANODE/CATHODE 10. ANODE/CATHODE 11. ANODE/CATHODE 12. ANODE/CATHODE 13. NO CONNECTION 14. COMMON ANODE	STYLE 11: PIN 1. CATHODE 2. CATHODE 3. CATHODE 4. CATHODE 5. CATHODE 6. CATHODE 7. CATHODE 8. ANODE 9. ANODE 10. ANODE 11. ANODE 12. ANODE 13. ANODE 14. ANODE	STYLE 12: PIN 1. COMMON CATHODE 2. COMMON ANODE 3. ANODE/CATHODE 4. ANODE/CATHODE 5. ANODE/CATHODE 6. COMMON ANODE 7. COMMON CATHODE 8. ANODE/CATHODE 9. ANODE/CATHODE 10. ANODE/CATHODE 11. ANODE/CATHODE 12. ANODE/CATHODE 13. ANODE/CATHODE 14. ANODE/CATHODE

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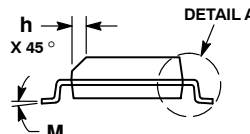
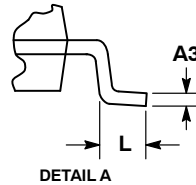
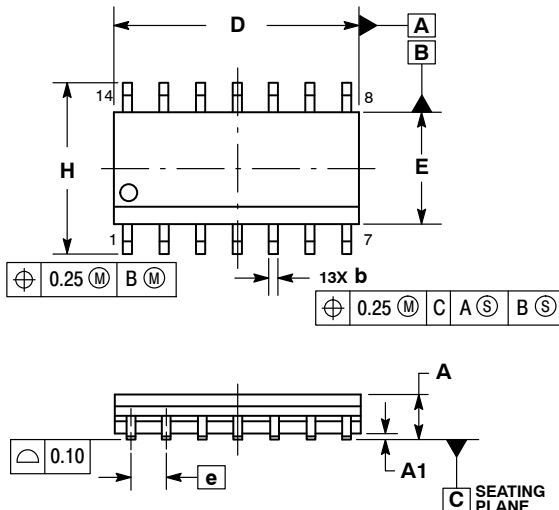
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SCALE 1:1

SOIC-14 NB
CASE 751A-03
ISSUE L

DATE 03 FEB 2016

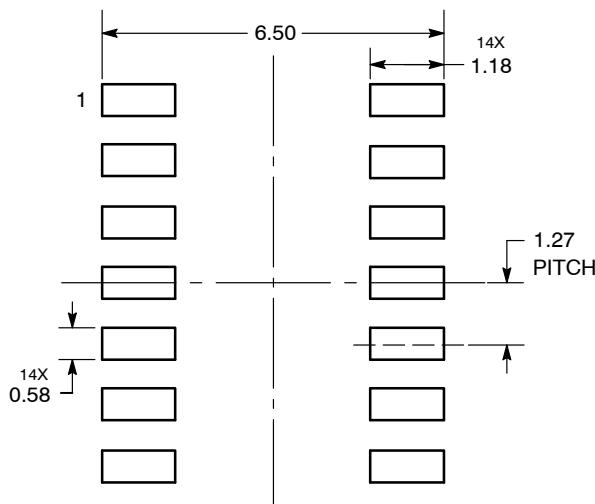


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.054	0.068
A1	0.10	0.25	0.004	0.010
A3	0.19	0.25	0.008	0.010
b	0.35	0.49	0.014	0.019
D	8.55	8.75	0.337	0.344
E	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
h	0.25	0.50	0.010	0.019
L	0.40	1.25	0.016	0.049
M	0°	7°	0°	7°

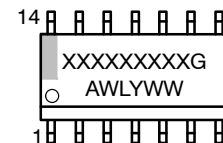
SOLDERING FOOTPRINT*



DIMENSIONS: MILLIMETERS

*For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

GENERIC
MARKING DIAGRAM*



XXXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
Y = Year
WW = Work Week
G = Pb-Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

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CASE 751A-03
ISSUE L

DATE 03 FEB 2016

STYLE 1:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. NO CONNECTION
5. ANODE/CATHODE
6. NO CONNECTION
7. ANODE/CATHODE
8. ANODE/CATHODE
9. ANODE/CATHODE
10. NO CONNECTION
11. ANODE/CATHODE
12. ANODE/CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 2:
CANCELLED

STYLE 3:
PIN 1. NO CONNECTION
2. ANODE
3. ANODE
4. NO CONNECTION
5. ANODE
6. NO CONNECTION
7. ANODE
8. ANODE
9. ANODE
10. NO CONNECTION
11. ANODE
12. ANODE
13. NO CONNECTION
14. COMMON CATHODE

STYLE 4:
PIN 1. NO CONNECTION
2. CATHODE
3. CATHODE
4. NO CONNECTION
5. CATHODE
6. NO CONNECTION
7. CATHODE
8. CATHODE
9. CATHODE
10. NO CONNECTION
11. CATHODE
12. CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 5:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. ANODE/CATHODE
5. ANODE/CATHODE
6. NO CONNECTION
7. COMMON ANODE
8. COMMON CATHODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. ANODE/CATHODE
12. ANODE/CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 6:
PIN 1. CATHODE
2. CATHODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE
7. CATHODE
8. ANODE
9. ANODE
10. ANODE
11. ANODE
12. ANODE
13. ANODE
14. ANODE

STYLE 7:
PIN 1. ANODE/CATHODE
2. COMMON ANODE
3. COMMON CATHODE
4. ANODE/CATHODE
5. ANODE/CATHODE
6. ANODE/CATHODE
7. ANODE/CATHODE
8. ANODE/CATHODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. COMMON CATHODE
12. COMMON ANODE
13. ANODE/CATHODE
14. ANODE/CATHODE

STYLE 8:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. NO CONNECTION
5. ANODE/CATHODE
6. ANODE/CATHODE
7. COMMON ANODE
8. COMMON ANODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. NO CONNECTION
12. ANODE/CATHODE
13. ANODE/CATHODE
14. COMMON CATHODE

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