# MC34060A, MC33060A

# Fixed Frequency, PWM, Voltage Mode Single Ended Controllers

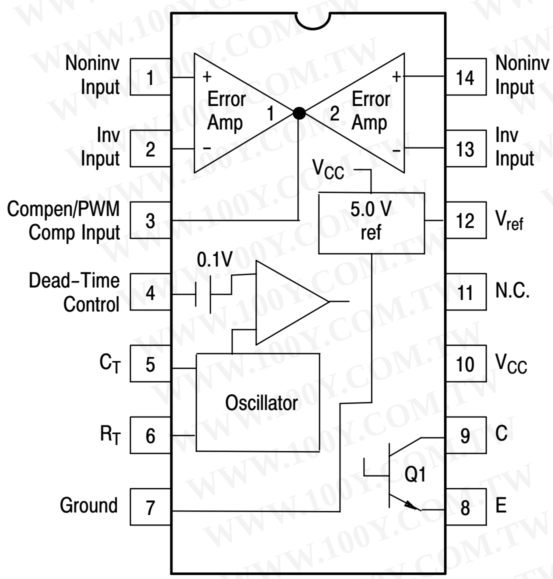
The MC34060A is a low cost fixed frequency, pulse width modulation control circuit designed primarily for single−ended SWITCHMODE™ power supply control.

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
- Pb−Free Packages are Available

**PIN CONNECTIONS**

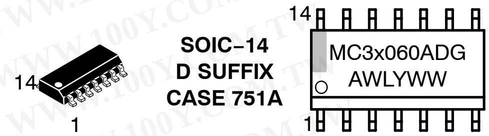



(Top View)

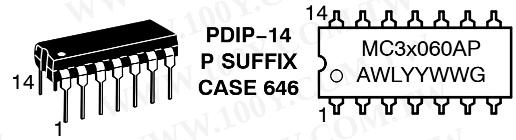
**ON Semiconductor®**

http://onsemi.com

**MARKING DIAGRAMS**




**SOIC−14**
**D SUFFIX**
**CASE 751A**




**PDIP−14**
**P SUFFIX**
**CASE 646**

| | | |
|---|---|---|
| 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.

**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 1) | $I_C$ | 500 | mA |
| Amplifier Input Voltage Range | $V_{in}$ | −0.3 to +42 | V |
| Power Dissipation @ $T_A \le 45°C$ | $P_D$ | 1000 | mW |
| Operating Junction Temperature | $T_J$ | 125 | °C |
| Storage Temperature Range | $T_{stg}$ | −55 to +125 | °C |
| Operating Ambient Temperature Range<br>For MC34060A<br>For MC33060A | $T_A$ | <br>0 to +70<br>−40 to +85 | °C |

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.

**THERMAL CHARACTERISTICS**

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

1. Maximum thermal limits must be observed.

**ELECTRICAL CHARACTERISTICS** ($V_{CC}$ = 15 V, $C_T$ = 0.01 μF, $R_T$ = 12 kΩ, unless otherwise noted. For typical values $T_A$ = 25°C, for min/max values $T_A$ is the operating ambient temperature range that applies, unless otherwise noted.)

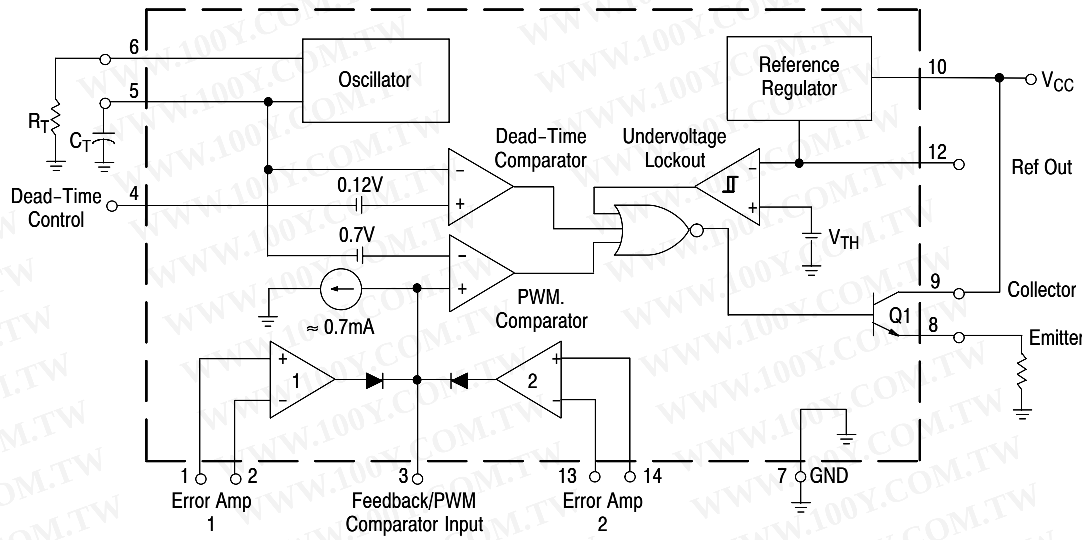
| Characteristics | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **REFERENCE SECTION** | | | | | |
| Reference Voltage ($I_O$ = 1.0 mA, $T_A$ 25°C)<br>$T_A = T_{low}$ to $T_{high}$ – MC34060A<br>– MC33060A | $V_{ref}$ | 4.925<br>4.9<br>4.85 | 5.0<br>–<br>– | 5.075<br>5.1<br>5.1 | V |
| Line Regulation ($V_{CC}$ = 7.0 V to 40 V, $I_O$ = 10 mA) | $Reg_{line}$ | – | 2.0 | 25 | mV |
| Load Regulation ($I_O$ = 1.0 mA to 10 mA) | $Reg_{load}$ | – | 2.0 | 15 | mV |
| Short Circuit Output Current ($V_{ref}$ = 0 V) | $I_{SC}$ | 15 | 35 | 75 | mA |
| **OUTPUT SECTION** | | | | | |
| Collector Off–State Current ($V_{CC}$ = 40 V, $V_{CE}$ = 40 V) | $I_{C(off)}$ | – | 2.0 | 100 | μA |
| Emitter Off–State Current ($V_{CC}$ = 40 V, $V_{CE}$ = 40 V, $V_E$ = 0 V) | $I_{E(off)}$ | – | – | –100 | μA |
| Collector–Emitter Saturation Voltage (Note 2)<br>Common–Emitter<br>($V_E$ = 0 V, $I_C$ = 200 mA)<br>Emitter–Follower<br>($V_C$ = 15 V, $I_E$ = –200 mA) | $V_{sat(C)}$<br><br><br>$V_{sat(E)}$ | –<br><br><br>– | 1.1<br><br><br>1.5 | 1.5<br><br><br>2.5 | V |
| Output Voltage Rise Time ($T_A$ = 25°C)<br>Common–Emitter (See Figure 12)<br>Emitter–Follower (See Figure 13) | $t_r$ | <br>–<br>– | <br>100<br>100 | <br>200<br>200 | ns |
| Output Voltage Fall Time ($T_A$ = 25°C)<br>Common–Emitter (See Figure 12)<br>Emitter–Follower (See Figure 13) | $t_r$ | <br>–<br>– | <br>40<br>40 | <br>100<br>100 | ns |
| **ERROR AMPLIFIER SECTION** | | | | | |
| Input Offset Voltage ($V_{O[Pin\ 3]}$ = 2.5 V) | $V_{IO}$ | – | 2.0 | 10 | mV |
| Input Offset Current ($V_{C[Pin\ 3]}$ = 2.5 V) | $I_{IO}$ | – | 5.0 | 250 | nA |
| Input Bias Current ($V_{O[Pin\ 3]}$ = 2.5 V) | $I_{IB}$ | – | –0.1 | –2.0 | μA |
| Input Common Mode Voltage Range<br>($V_{CC}$ = 40 V) | $V_{ICR}$ | 0 to<br>$V_{CC}$ –2.0 | – | – | V |
| Inverting Input Voltage Range | $V_{IR(INV)}$ | –0.3 to<br>$V_{CC}$–2.0 | – | – | V |
| Open–Loop Voltage Gain<br>($\Delta V_O$ = 3.0 V, $V_O$ = 0.5 V to 3.5 V, $R_L$ = 2.0 kΩ) | $A_{VOL}$ | 70 | 95 | – | dB |
| Unity–Gain Crossover Frequency<br>($V_O$ = 0.5 V to 3.5 V, $R_L$ = 2.0 kΩ) | $f_c$ | – | 600 | – | kHz |
| Phase Margin at Unity–Gain<br>($V_O$ = 0.5 V to 3.5 V, $R_L$ = 2.0 kΩ) | $\phi_m$ | – | 65 | – | deg. |
| Common Mode Rejection Ratio<br>($V_{CC}$ = 40 V, $V_{in}$ = 0 V to 38 V)) | CMRR | 65 | 90 | – | dB |
| Power Supply Rejection Ratio<br>($\Delta V_{CC}$ = 33 V, $V_O$ = 2.5 V, $R_L$ = 2.0 kΩ) | PSRR | – | 100 | – | dB |
| Output Sink Current ($V_{O[Pin\ 3]}$ = 0.7 V) | $I_{O-}$ | 0.3 | 0.7 | – | mA |
| Output Source Current ($V_{O[Pin\ 3]}$ = 3.5 V) | $I_{O+}$ | –2.0 | –4.0 | – | mA |

2. Low duty cycle techniques are used during test to maintain junction temperature as close to ambient temperatures as possible.
$T_{low}$ = –40°C for MC33060A  $T_{high}$ = +85°C for MC33060A
= 0°C for MC34060A  = +70°C for MC34060A

**ELECTRICAL CHARACTERISTICS (continued)** ($V_{CC}$ = 15 V, $C_T$ = 0.01 μF, $R_T$ = 12 kΩ, unless otherwise noted.
For typical values $T_A$ = 25°C, for min/max values $T_A$ is the operating ambient temperature range that applies, unless otherwise noted.)

| Characteristics | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **PWM COMPARATOR SECTION** (Test circuit Figure 11) | | | | | |
| Input Threshold Voltage<br>(Zero Duty Cycle) | $V_{TH}$ | – | 3.5 | 4.5 | V |
| Input Sink Current<br>($V_{[Pin\ 3]}$ = 0.7 V) | $I_I$ | 0.3 | 0.7 | – | mA |
| **DEAD–TIME CONTROL SECTION** (Test circuit Figure 11) | | | | | |
| Input Bias Current (Pin 4)<br>($V_{in}$ = 0 V to 5.25 V) | $I_{IB(DT)}$ | – | −1.0 | −10 | μA |
| Maximum Output Duty Cycle<br>($V_{in}$ = 0 V, $C_T$ = 0.01 μF, $R_T$ = 12 kΩ)<br>($V_{in}$ = 0 V, $C_T$ = 0.001 μF, $R_T$ = 47 kΩ) | $DC_{max}$ | <br>90<br>– | <br>96<br>92 | <br>100<br>– | % |
| Input Threshold Voltage (Pin 4)<br>(Zero Duty Cycle)<br>(Maximum Duty Cycle) | $V_{TH}$ | <br>–<br>0 | <br>2.8<br>– | <br>3.3<br>– | V |
| **OSCILLATOR SECTION** | | | | | |
| Frequency<br>($C_T$ = 0.01 μF, $R_T$ = 12 kΩ, $T_A$ = 25°C)<br>$T_A$ = $T_{low}$ to $T_{high}$ – MC34060A<br>– MC33060A<br>($C_T$ = 0.001 μF, $R_T$ = 47 kΩ) | $f_{osc}$ | <br>9.7<br>9.5<br>9.0<br>– | <br>10.5<br>–<br>–<br>25 | <br>11.3<br>11.5<br>11.5<br>– | kHz |
| Standard Deviation of Frequency*<br>($C_T$ = 0.001 μF, $R_T$ = 47 kΩ) | $\sigma f_{osc}$ | – | 1.5 | – | % |
| Frequency Change with Voltage<br>($V_{CC}$ = 7.0 V to 40 V) | $\Delta f_{osc}(\Delta V)$ | – | 0.5 | 2.0 | % |
| Frequency Change with Temperature<br>($\Delta T_A$ = $T_{low}$ to $T_{high}$)<br>($C_T$ = 0.01 μF, $R_T$ = 12 kΩ) | $\Delta f_{osc}(\Delta T)$ | <br>–<br>– | <br>4.0<br>– | <br>–<br>– | % |
| **UNDERVOLTAGE LOCKOUT SECTION** | | | | | |
| Turn–On Threshold ($V_{CC}$ increasing, $I_{ref}$ = 1.0 mA) | $V_{th}$ | 4.0 | 4.7 | 5.5 | V |
| Hysteresis | $V_H$ | 50 | 150 | 300 | mV |
| **TOTAL DEVICE** | | | | | |
| Standby Supply Current<br>(Pin 6 at $V_{ref}$, all other inputs and outputs open)<br>($V_{CC}$ = 15 V)<br>($V_{CC}$ = 40 V) | $I_{CC}$ | <br><br>–<br>– | <br><br>5.5<br>7.0 | <br><br>10<br>15 | mA |
| Average Supply Current<br>($V_{[Pin\ 4]}$ = 2.0 V, $C_T$ = 0.001 μF, $R_T$ = 47 kΩ). 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; $\sigma = \sqrt{\frac{\sum^{N} (x_n - x)^2}{N-1}}$




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.)

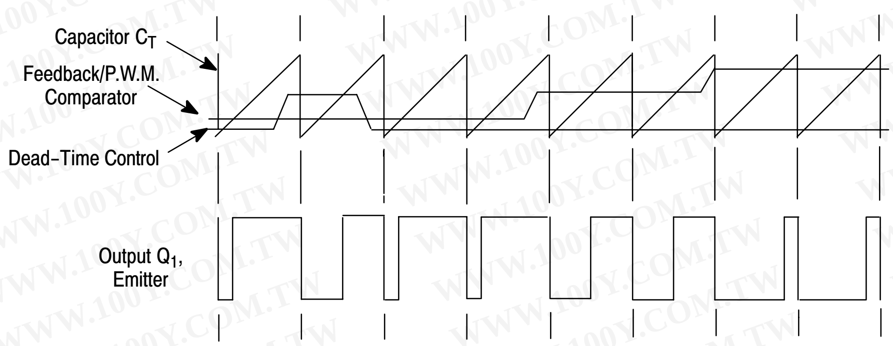



**Figure 2. Timing Diagram**

## 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 ±5% with a typical thermal drift of less than 50 mV over an operating temperature range of 0° to +70°C.

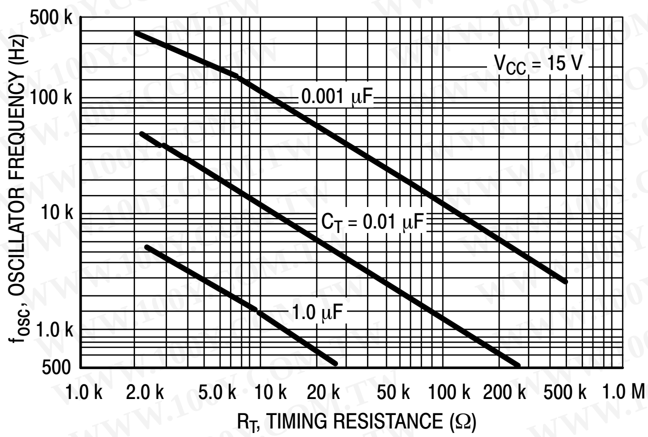



**Figure 3. Oscillator Frequency versus Timing Resistance**

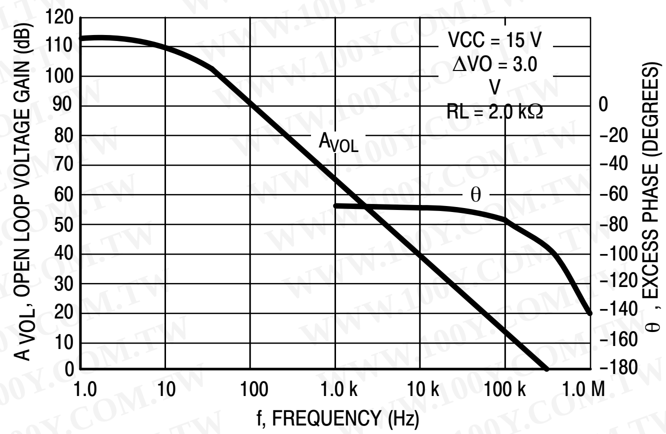



**Figure 4. Open Loop Voltage Gain and Phase versus Frequency**

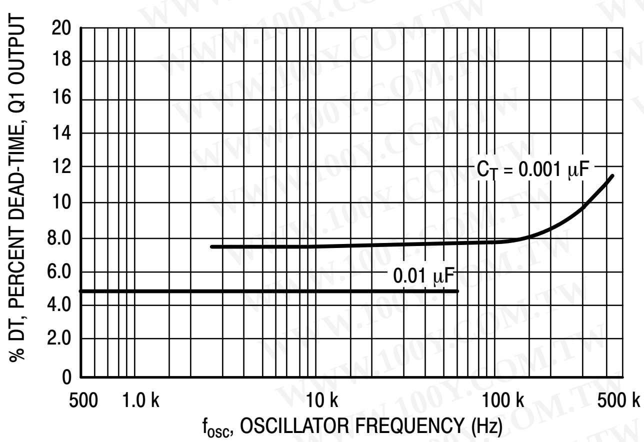



**Figure 5. Percent Deadtime versus Oscillator Frequency**

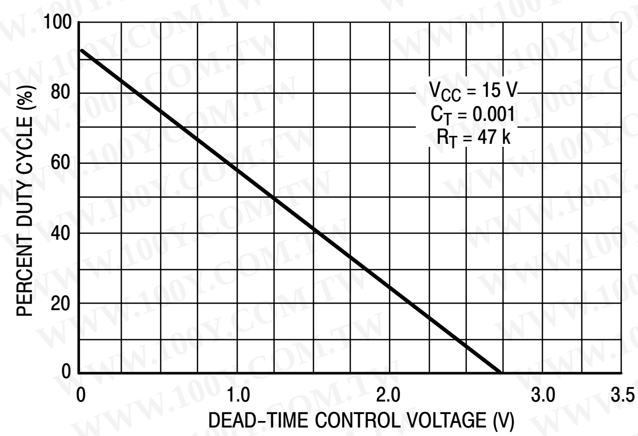



**Figure 6. Percent Duty Cycle versus Dead−Time Control Voltage**

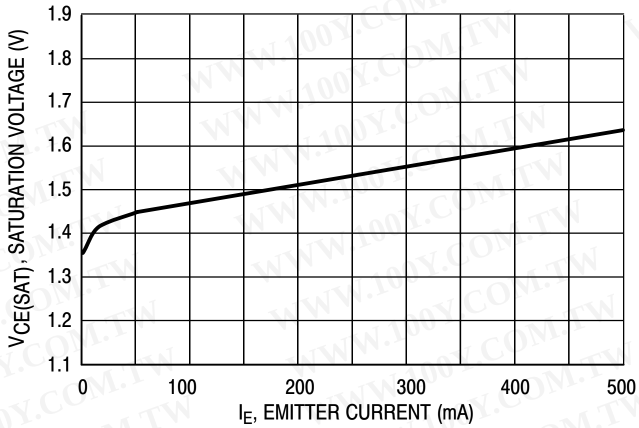



**Figure 7. Emitter−Follower Configuration Output Saturation Voltage versus Emitter Current**

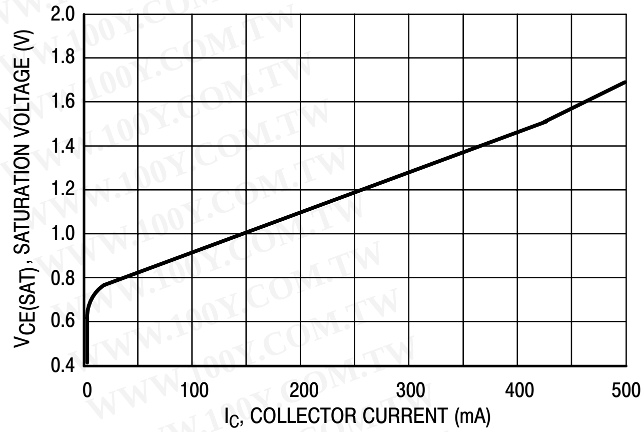



**Figure 8. Common−Emitter Configuration Output Saturation Voltage versus Collector Current**

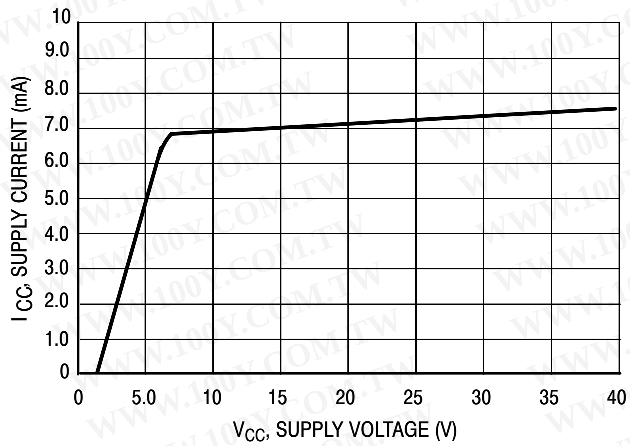



**Figure 9. Standby Supply Current versus Supply Voltage**

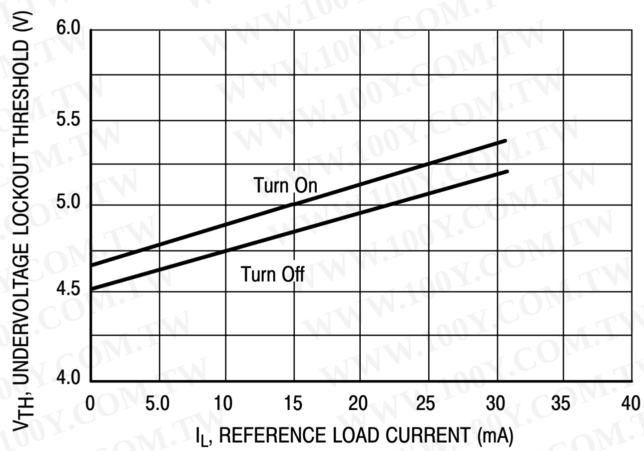



**Figure 10. Undervoltage Lockout Thresholds versus Reference Load Current**

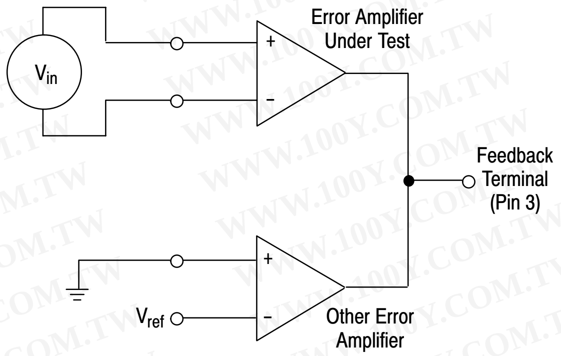



Figure 11. Error Amplifier Characteristics

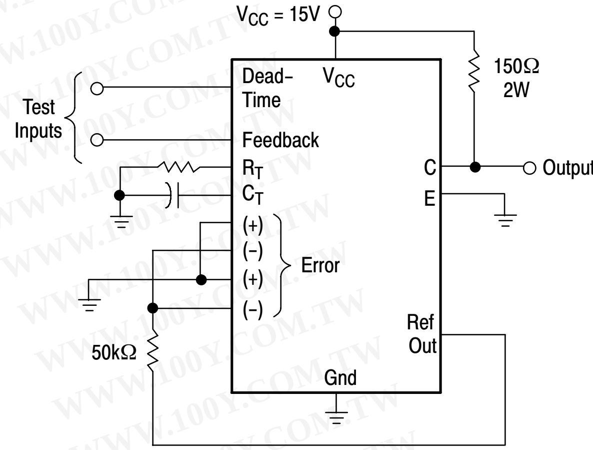



Figure 12. Deadtime and Feedback Control

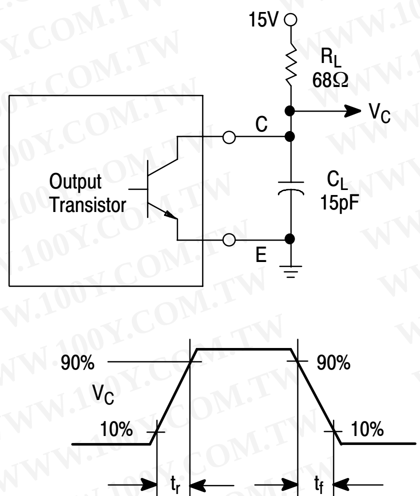



Figure 13. Common−Emitter Configuration and Waveform

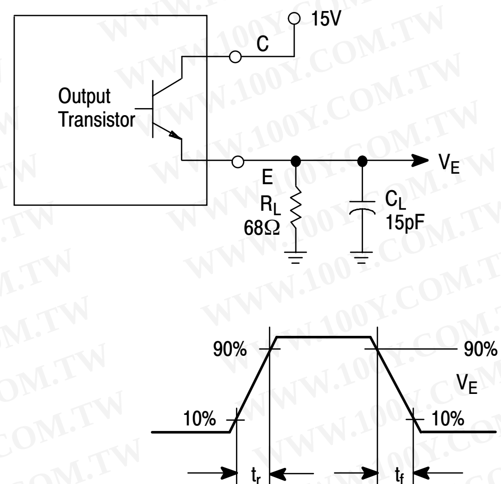



Figure 14. Emitter−Follower Configuration and Waveform

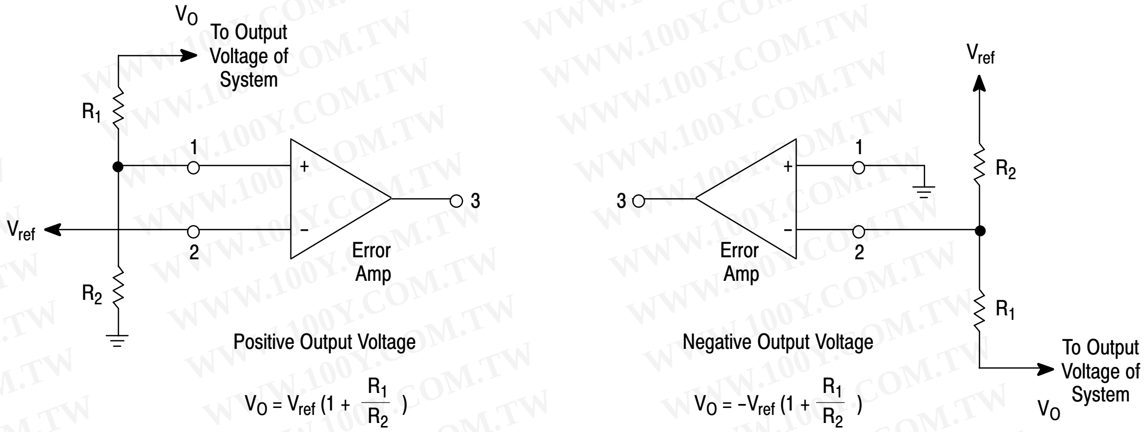



**Figure 15. Error Amplifier Sensing Techniques**

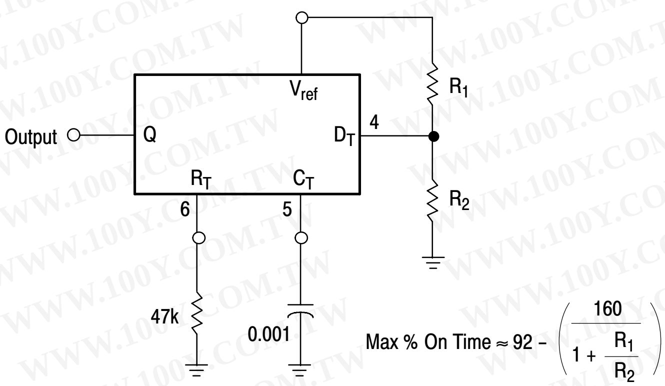



**Figure 16. Deadtime Control Circuit**

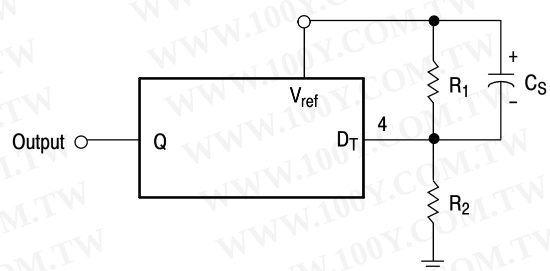



**Figure 17. Soft−Start Circuit**

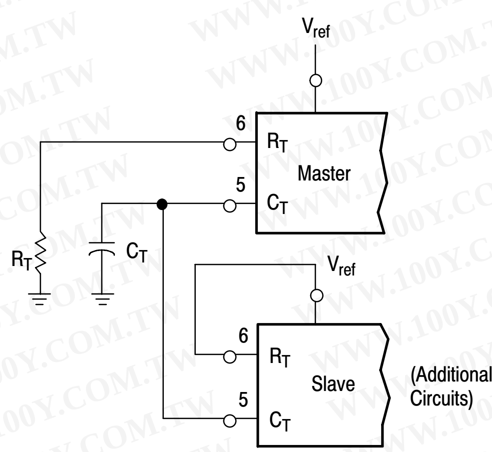
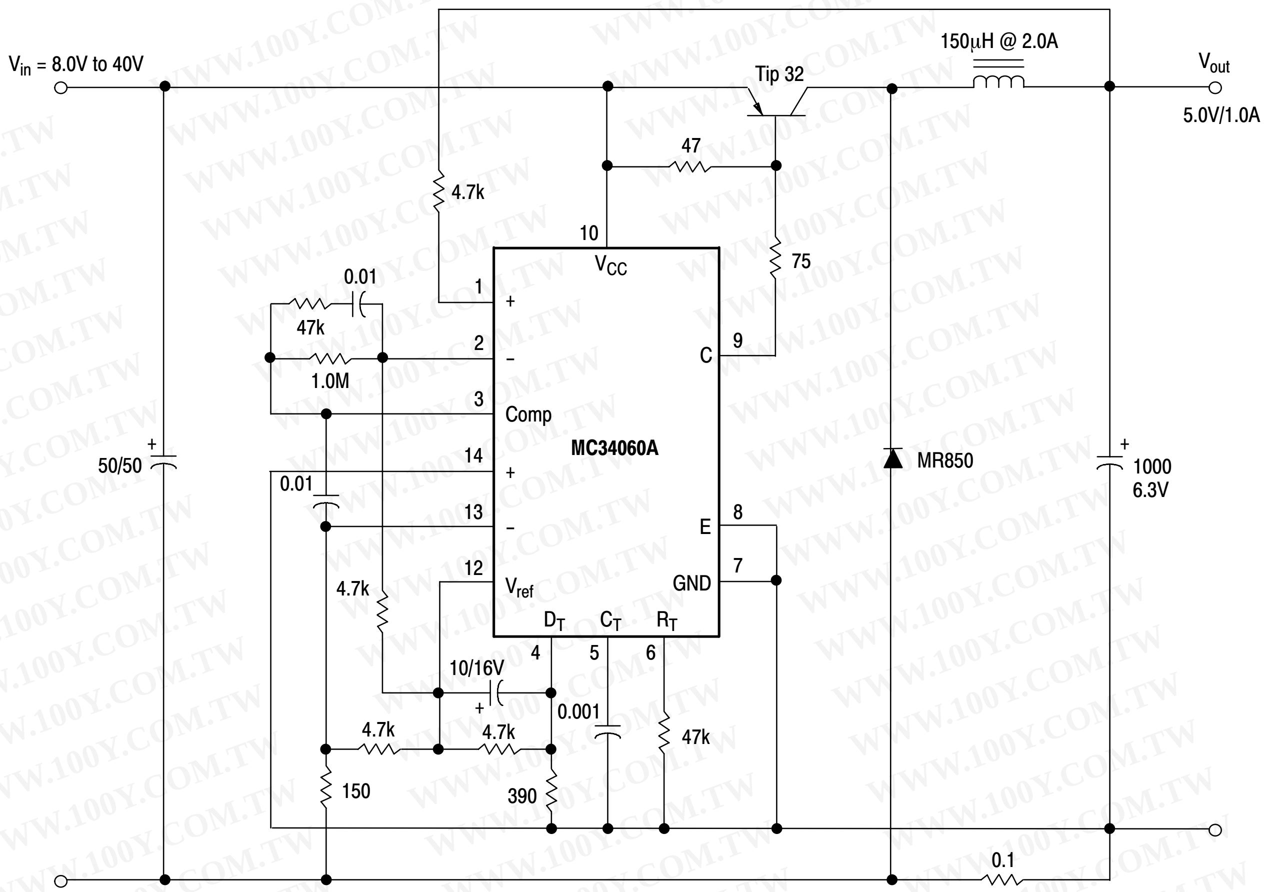
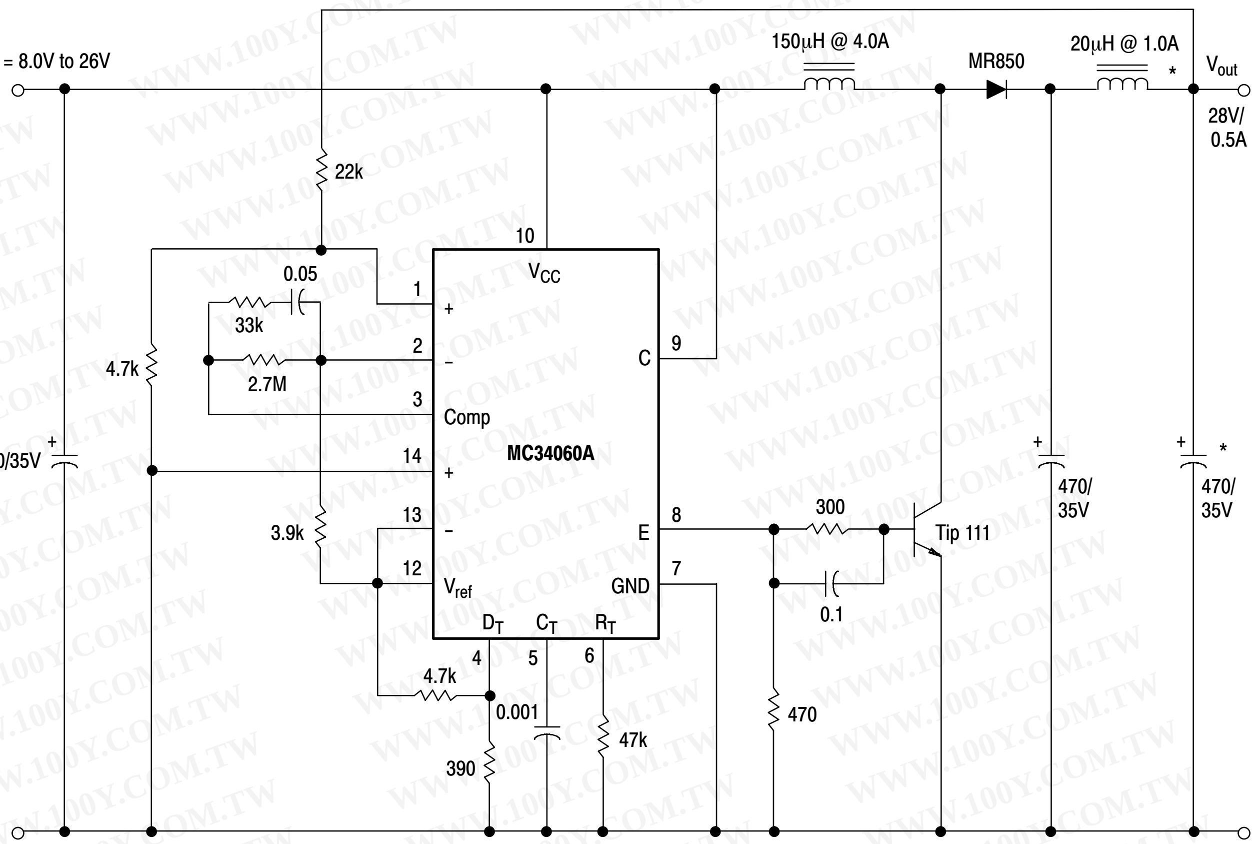



**Figure 18. Slaving Two or More Control Circuits**




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

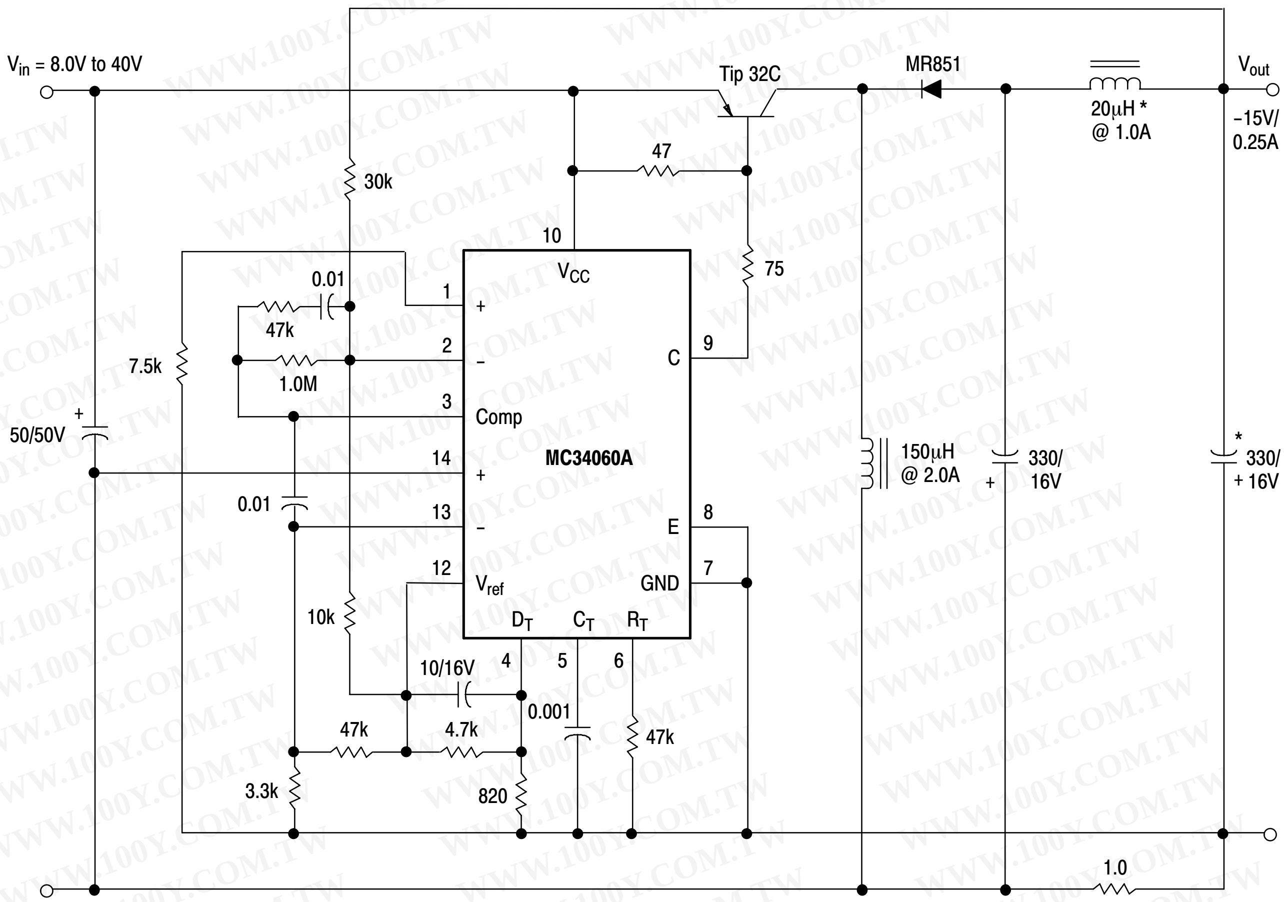
**Figure 19. Step–Down Converter with Soft–Start and Output Current Limiting**




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

*Optional circuit to minimize output ripple

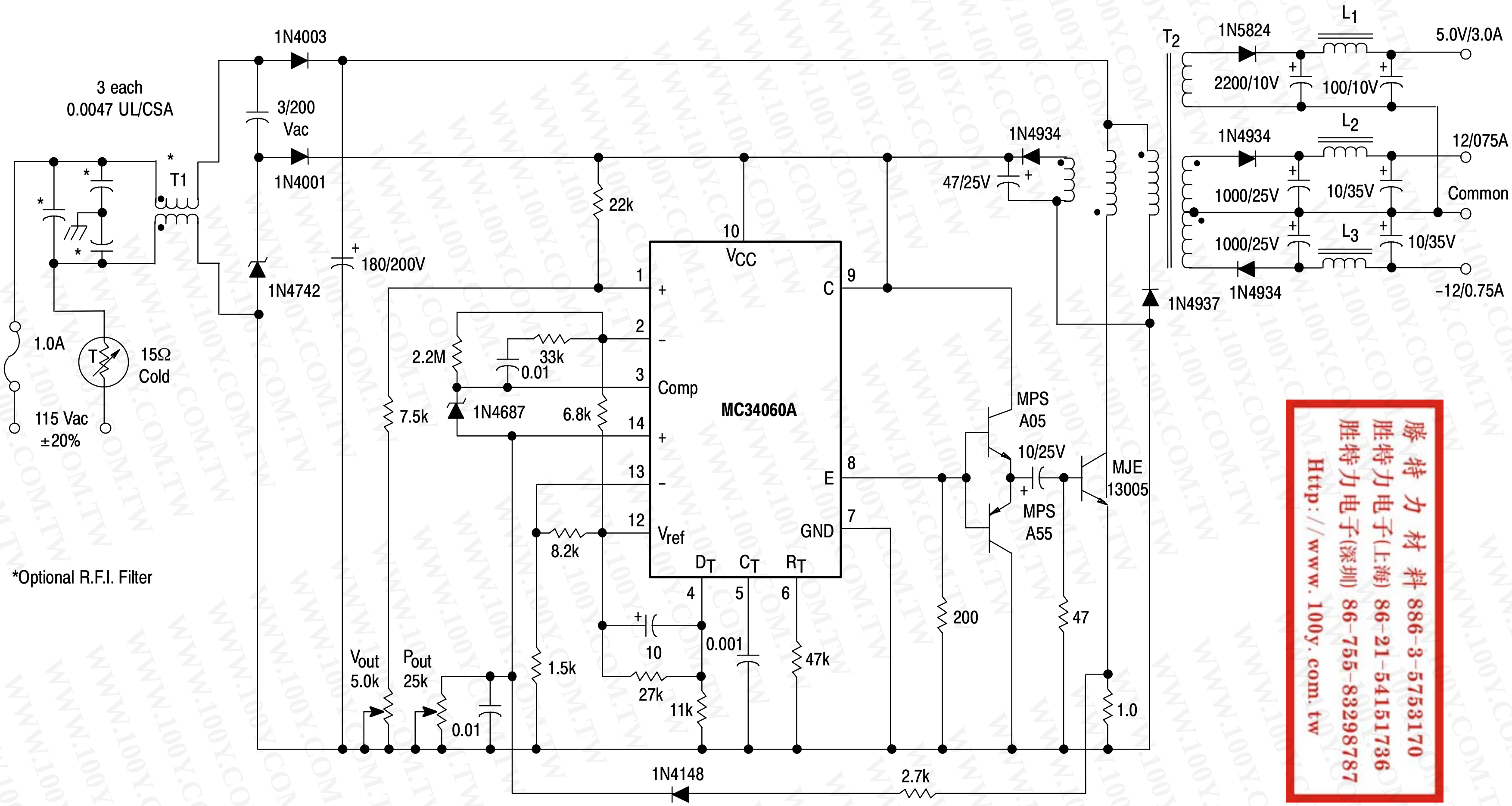
**Figure 20. Step–Up Converter**




| Test | Conditions | Results |
|---|---|---|
| Line Regulation | $V_{in}$ = 8.0 V to 40 V, $I_O$ = 250 mA | 52 mV 0.35% |
| Load Regulation | $V_{in}$ = 12 V, $I_O$ = 1.0 to 250 mA | 47 mV 0.32% |
| Output Ripple | $V_{in}$ = 12 V, $I_O$ = 250 mA | 10 mV p–p P.A.R.D. |
| Short Circuit Current | $V_{in}$ = 12 V, $R_L$ = 0.1 Ω | 330 mA |
| Efficiency | $V_{in}$ = 12 V, $I_O$ = 250 mA | 86% |

*Optional circuit to minimize output ripple

**Figure 21. Step–Up/Down Voltage Inverting Converter with Soft–Start and Current Limiting**






| Test | Conditions | Results |
|---|---|---|
| Line Regulation 5.0 V | $V_{in}$ = 95 Vac to 135 Vac, $I_O$ = 3.0 A | 20 mV 0.40% |
| Line Regulation ±12 V | $V_{in}$ = 95 Vac to 135 Vac, $I_O$ = ±0.75 A | 52 mV 0.26% |
| Load Regulation 5.0 V | $V_{in}$ = 115 Vac, $I_O$ = 1.0 A to 4.0 A | 476 mV 9.5% |
| Load Regulation ±12 V | $V_{in}$ = 115 Vac, $I_O$ = ±0.4 A to ±0.9 A | 300 mV 2.5% |
| Output Ripple 5.0 V | $V_{in}$ = 115 Vac, $I_O$ = 3.0 A | 45 mV p–p P.A.R.D. |
| Output Ripple ±12 V | $V_{in}$ = 115 Vac, $I_O$ = ±0.75 A | 75 mV p–p P.A.R.D. |
| Efficiency | $V_{in}$ = 115 Vac, $I_O$ 5.0 V = 3.0 A<br>$I_O$ ±12 V = ±0.75 A | 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, 2 each, 14 turns #24 Awg Bifilar wound
L1 – Coilcraft Z7156, 15 μH @ 5.0 A
L2, L3 – Coilcraft Z7157, 25μH @ 1.0 A

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

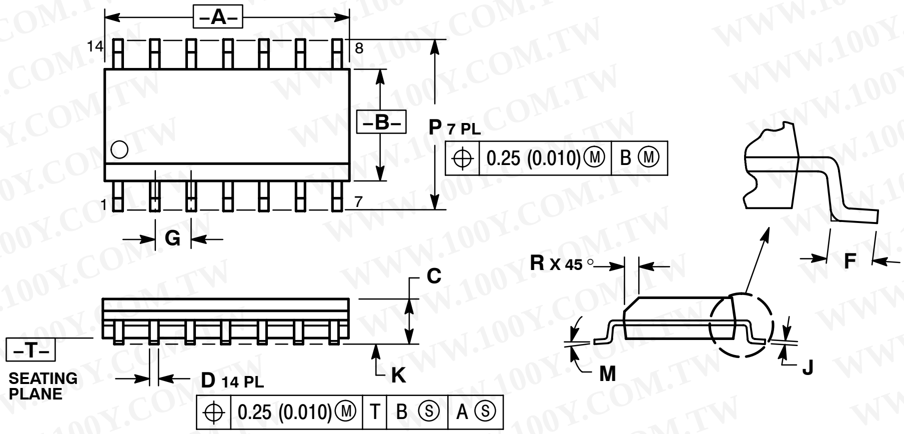
## ORDERING INFORMATION

| Device | Operating Temperature Range | Package | Shipping† |
|---|---|---|---|
| MC34060AD | $T_A$= 0° to +70°C | SOIC–14 | 55 Units / Rail |
| MC34060ADG | | SOIC–14 (Pb–Free) | |
| MC34060ADR2 | | SOIC–14 | 2500 / Tape & Reel |
| MC34060ADR2G | | SOIC–14 (Pb–Free) | |
| MC34060AP | | PDIP–14 | 25 Units / Rail |
| MC34060APG | | PDIP–14 (Pb–Free) | |
| MC33060AD | $T_A$= –40° to +85°C | SOIC–14 | 55 Units / Rail |
| MC33060ADG | | SOIC–14 (Pb–Free) | |
| MC33060ADR2 | | SOIC–14 | 2500 / Tape & Reel |
| MC33060ADR2G | | SOIC–14 (Pb–Free) | |
| MC33060AP | | PDIP–14 | 25 Units / Rail |
| MC33060APG | | PDIP–14 (Pb–Free) | |

†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.

## PACKAGE DIMENSIONS

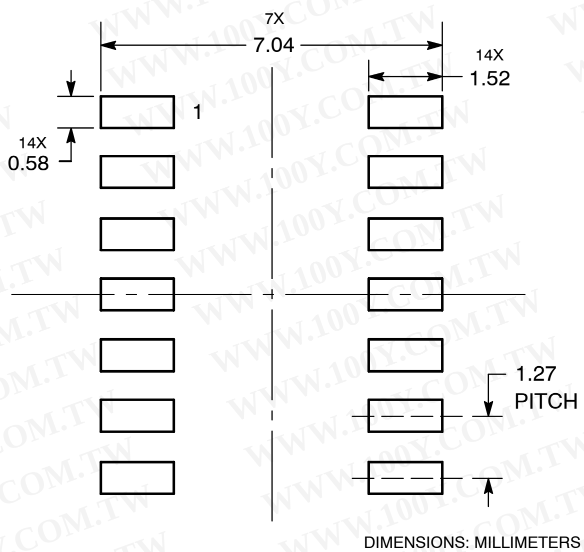
**SOIC−14**
CASE 751A−03
ISSUE H




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.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | 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 |

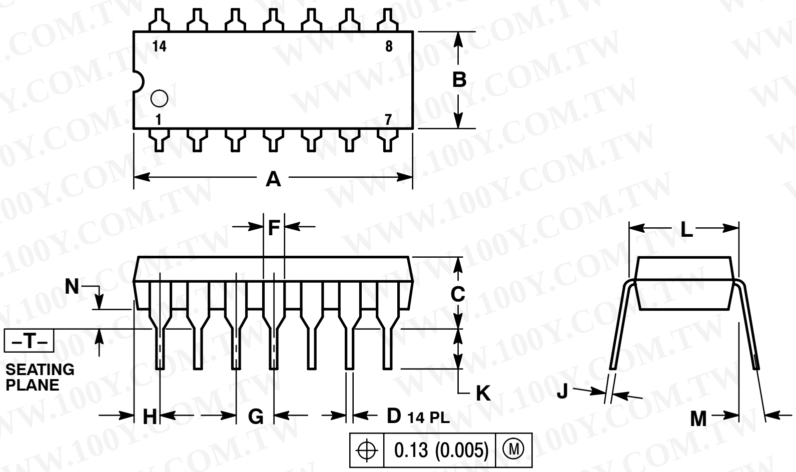
## SOLDERING FOOTPRINT*




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

## PACKAGE DIMENSIONS

**PDIP−14**
CASE 646−06
ISSUE P




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.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.715 | 0.770 | 18.16 | 19.56 |
| B | 0.240 | 0.260 | 6.10 | 6.60 |
| C | 0.145 | 0.185 | 3.69 | 4.69 |
| D | 0.015 | 0.021 | 0.38 | 0.53 |
| F | 0.040 | 0.070 | 1.02 | 1.78 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.052 | 0.095 | 1.32 | 2.41 |
| J | 0.008 | 0.015 | 0.20 | 0.38 |
| K | 0.115 | 0.135 | 2.92 | 3.43 |
| L | 0.290 | 0.310 | 7.37 | 7.87 |
| M | --- | 10 ° | --- | 10 ° |
| N | 0.015 | 0.039 | 0.38 | 1.01 |





**PUBLICATION ORDERING INFORMATION**

**LITERATURE FULFILLMENT**:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
**Phone**: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
**Fax**: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
**Email**: orderlit@onsemi.com

**N. American Technical Support**: 800−282−9855 Toll Free USA/Canada
**Europe, Middle East and Africa Technical Support:**
Phone: 421 33 790 2910
**Japan Customer Focus Center**
Phone: 81−3−5773−3850

**ON Semiconductor Website: www.onsemi.com**

**Order Literature**: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative