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MOTOROLA

MC34160
MC33160

Microprocessor Voltage Regulator and Supervisory Circuit

The MC34160 Series is a voltage regulator and supervisory circuit containing many of the necessary monitoring functions required in microprocessor based systems. It is specifically designed for appliance and industrial applications, offering the designer a cost effective solution with minimal external components. These integrated circuits feature a 5.0 V/100 mA regulator with short circuit current limiting, pinned out 2.6 V bandgap reference, low voltage reset comparator, power warning comparator with programmable hysteresis, and an uncommitted comparator ideally suited for microprocessor line synchronization.

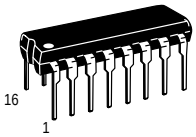
Additional features include a chip disable input for low standby current, and internal thermal shutdown for over temperature protection.

These devices are contained in a 16 pin dual–in–line heat tab plastic package for improved thermal conduction.

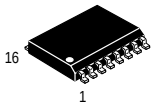
- 5.0 V Regulator Output Current in Excess of 100 mA
- Internal Short Circuit Current Limiting
- Pinned Out 2.6 V Reference
- Low Voltage Reset Comparator
- Power Warning Comparator with Programmable Hysteresis
- Uncommitted Comparator
- Low Standby Current
- Internal Thermal Shutdown Protection
- Heat Tab Power Package

MICROPROCESSOR VOLTAGE REGULATOR/ SUPERVISORY CIRCUIT

SEMICONDUCTOR TECHNICAL DATA

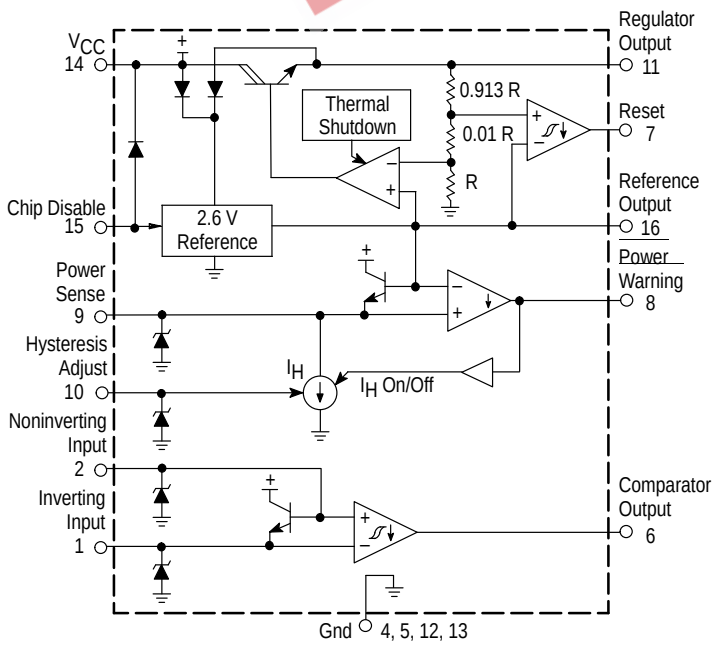


P SUFFIX
PLASTIC PACKAGE
CASE 648C
(DIP–16)



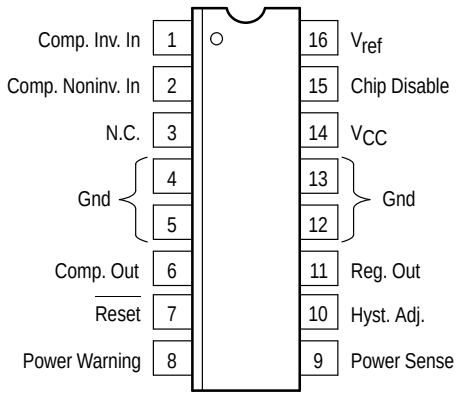
DW SUFFIX
PLASTIC PACKAGE
CASE 751G
(SOP–16L)

Representative Block Diagram



This device contains 72 active transistors.

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC34160DW	T_A = 0° to +70°C	SOP–16L
MC34160P		DIP–16
MC33160DW	T_A = – 40° to +85°C	SOP–16L
MC33160P		DIP–16

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	40	V
Chip Disable Input Voltage (Pin 15, Note 1)	V_{CD}	–0.3 to V_{CC}	V
Comparator Input Current (Pins 1, 2, 9)	I_{in}	–2.0 to +2.0	mA
Comparator Output Voltage (Pins 6, 7, 8)	V_O	40	V
Comparator Output Sink Current (Pins 6, 7, 8)	I_{Sink}	10	mA
Power Dissipation and Thermal Characteristics P Suffix, Dual–In–Line Case 648C Thermal Resistance, Junction–to–Air Thermal Resistance, Junction–to–Case (Pins 4, 5, 12, 13) DW Suffix, Surface Mount Case 751G Thermal Resistance, Junction–to–Air Thermal Resistance, Junction–to–Case (Pins 4, 5, 12, 13)	 $R_{\theta JA}$ $R_{\theta JC}$ $R_{\theta JA}$ $R_{\theta JC}$	 80 15 94 18	°C/W
Operating Junction Temperature	T_J	+150	°C
Operating Ambient Temperature MC34160 MC33160	T_A	 0 to +70 –40 to +85	°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

ELECTRICAL CHARACTERISTICS (V_{CC} = 30 V, I_O = 10 mA, I_{ref} = 100 µA) For typical values T_A = 25°C, for min/max values T_A is the operating ambient temperature range that applies [Notes 2 and 3], unless otherwise noted.)

Characteristics	Symbol	Min	Typ	Max	Unit
REGULATOR SECTION					
Total Output Variation (V_{CC} = 7.0 V to 40 V, I_O = 1.0 mA to 100 mA, T_A = T_{low} to T_{high})	V_O	4.75	5.0	5.25	V
Line Regulation (V_{CC} = 7.0 V to 40 V, T_A = 25°C)	Reg_{line}	–	5.0	40	mV
Load Regulation (I_O = 1.0 V to 100 mA, T_A = 25°C)	Reg_{load}	–	20	50	mV
Ripple Rejection (V_{CC} = 25 V to 35 V, I_O = 40 mA, f = 120 Hz, T_A = 25°C)	RR	50	6.5	–	dB
REFERENCE SECTION					
Total Output Variation (V_{CC} = 7.0 to 40 V, I_O = 0.1 mA to 2.0 mA, T_A = T_{low} to T_{high})	V_{ref}	2.47	2.6	2.73	V
Line Regulation (V_{CC} = 5.0 V to 40 V, T_A = 25°C)	Reg_{line}	–	2.0	20	mV
Load Regulation (I_O = 0.1 mA to 2.0 mA, T_A = 25°C)	Reg_{load}	–	4.0	30	mV
RESET COMPARATOR					
Threshold Voltage High State Output (Pin 11 Increasing) Low State Output (Pin 11 Decreasing) Hysteresis	 V_{IH} V_{IL} V_H	 – 4.55 0.02	 (V_O–0.11) (V_O–0.18) 0.07	 (V_O–0.05) – –	V
Output Sink Saturation (V_{CC} = 4.5 V, I_{Sink} = 2.0 mA)	V_{OL}	–	–	0.4	V
Output Off–State Leakage (V_{OH} = 40 V)	I_{OH}	–	–	4.0	µA

NOTES: 1. The maximum voltage range is –0.3 V to V_{CC} or +35 V, whichever is less.
2. T_{low} = 0°C for MC34160, –40°C for MC33160; T_{high} = 70°C for MC34160, 85°C for MC33160
3. Low duty cycle pulse testing techniques are used during test to maintain junction temperature as close to ambient as possible.

ELECTRICAL CHARACTERISTICS (continued) (V_{CC} = 30 V, I_O = 10 mA, I_{ref} = 100 µA) For typical values T_A = 25°C, for min/max values T_A is the operating ambient temperature range that applies [Notes 2 and 3], unless otherwise noted.)

Characteristics	Symbol	Min	Typ	Max	Unit
POWER WARNING COMPARATOR					
Input Offset Voltage	V_{IO}	–	1.2	10	mV
Input Bias Current ($V_{Pin\ 9}$ = 3.0 V)	I_{IB}	–	–	0.5	µA
Input Hysteresis Current ($V_{Pin\ 9} = V_{ref} – 100$ mV) $R_{Pin\ 10}$ = 24 k $R_{Pin\ 10} = \infty$	I_H	 40 4.5	 50 7.5	 60 11	µA
Output Sink Saturation (I_{Sink} = 2.0 mA)	V_{OL}	–	0.13	0.4	V
Output Off–State Leakage (V_{OH} = 40 V)	I_{OH}	–	–	4.0	µA
UNCOMMITTED COMPARATOR					
Input Offset Voltage (Output Transition Low to High)	V_{IO}	–	–	20	mV
Input Hysteresis Voltage (Output Transition High to Low)	I_H	140	200	260	mV
Input Bias Current ($V_{Pin\ 1, 2}$ = 2.6 V)	I_{IB}	–	–	–1.0	µA
Input Common Mode Voltage Range	V_{ICR}	0.6 to 5.0	–	–	V
Output Sink Saturation (I_{Sink} = 2.0 mA)	V_{OL}	–	0.13	0.4	V
Output Off–State Leakage (V_{OH} = 40 V)	I_{OH}	–	–	4.0	µA
TOTAL DEVICE					
Chip Disable Threshold Voltage (Pin 15) High State (Chip Disabled) Low State (Chip Enabled)	 V_{IH} V_{IL}	 2.5 –	 – –	 – 0.8	V
Chip Disable Input Current (Pin 15) High State (V_{in} = 2.5 V) Low State (V_{in} = 0.8 V)	 I_{IH} I_{IL}	 – –	 – –	 100 30	µA
Chip Disable Input Resistance (Pin 15)	R_{in}	50	100	–	kΩ
Operating Voltage Range V_O (Pin 11) Regulated V_{ref} (Pin 16) Regulated	V_{CC}	 7.0 to 40 5.0 to 40	 – –	 – –	V
Power Supply Current Standby (Chip Disable High State) Operating (Chip Disable Low State)	I_{CC}	 – –	 0.18 1.5	 0.35 3.0	mA

NOTES: 1. The maximum voltage range is –0.3 V to V_{CC} or +35 V, whichever is less.
2. T_{low} = 0°C for MC34160, –40°C for MC33160; T_{high} = 70°C for MC34160, 85°C for MC33160
3. Low duty cycle pulse testing techniques are used during test to maintain junction temperature as close to ambient as possible.

Figure 1. Regulator Output Voltage Change versus Source Current

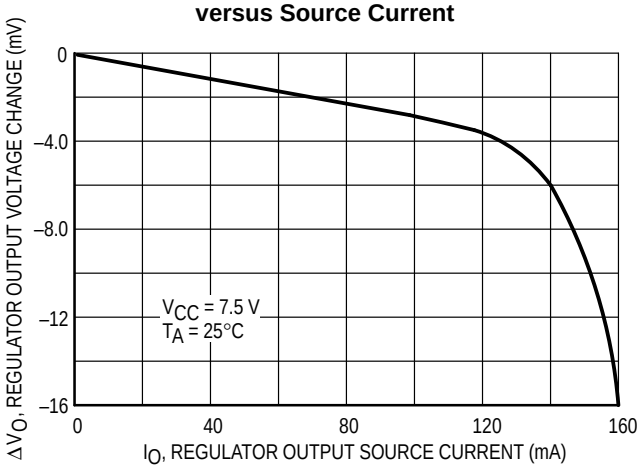


Figure 2. Reference and Regulator Output versus Supply Voltage

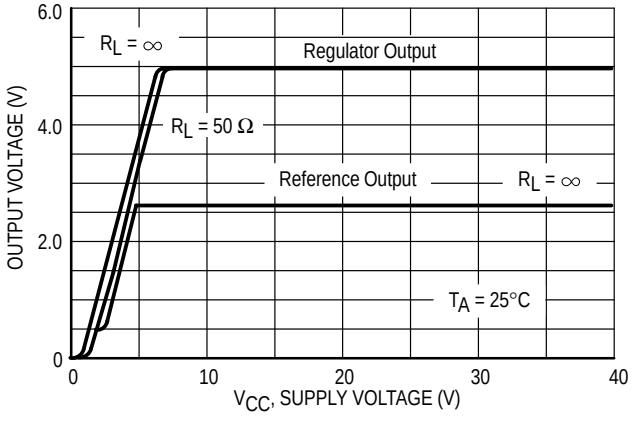


Figure 3. Reference Output Voltage Change versus Source Current

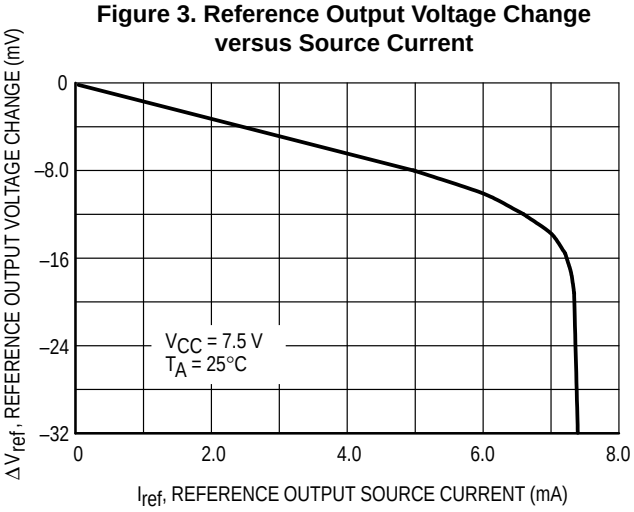


Figure 4. Power Warning Hysteresis Current versus Programming Resistor

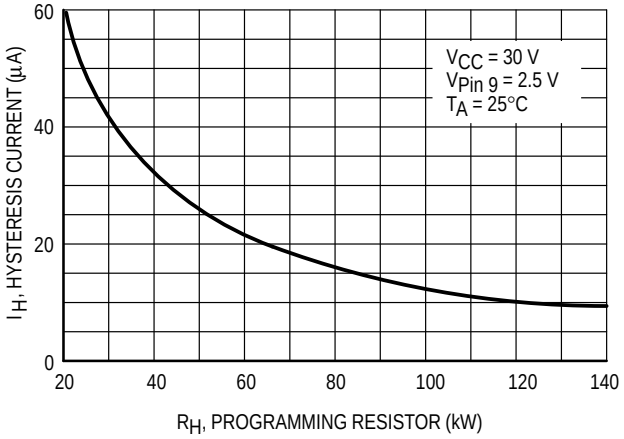


Figure 5. Power Warning Comparator Delay versus Temperature

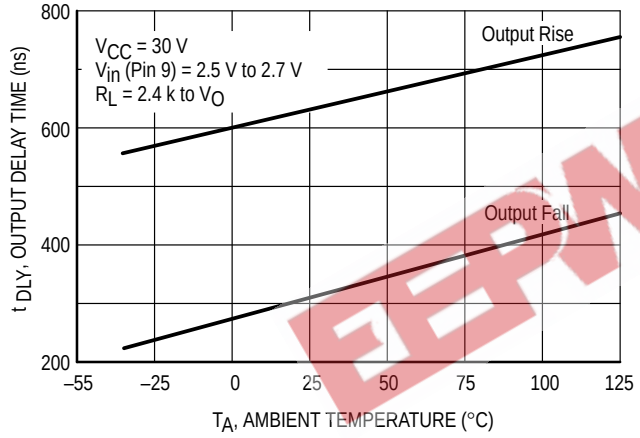


Figure 6. Uncommitted Comparator Delay versus Temperature

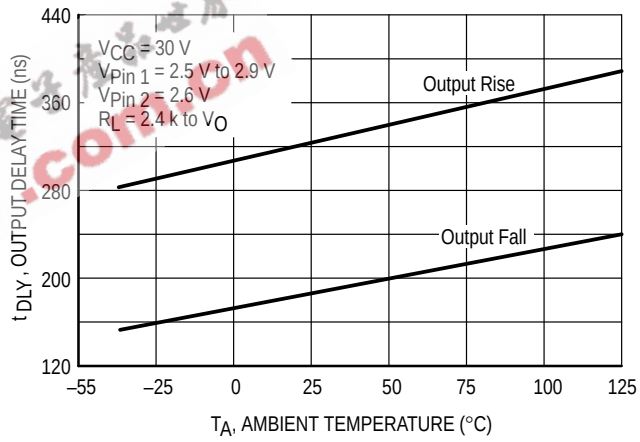


Figure 7. Comparator Output Saturation versus Sink Current

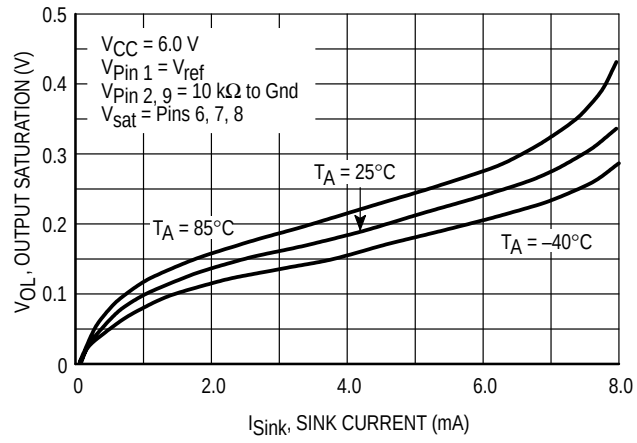


Figure 8. P Suffix (DIP–16) Thermal Resistance and Maximum Power DIssipation versus P.C.B. Copper Length

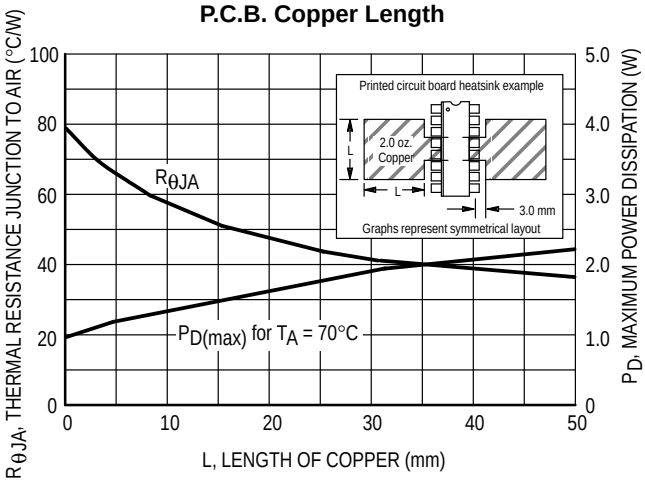
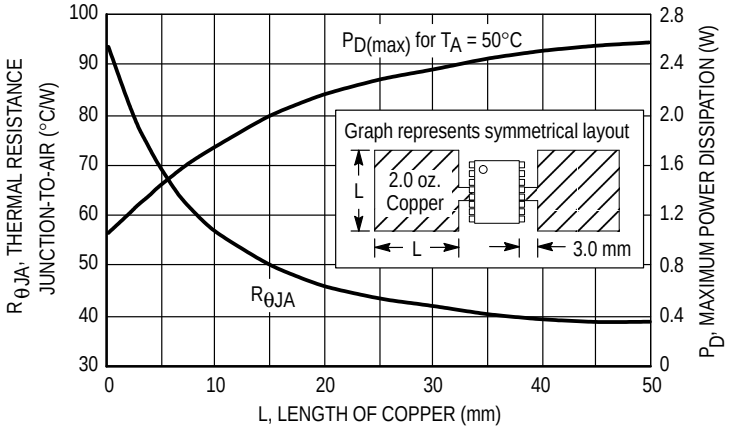


Figure 9. DW Suffix (SOP–16L) Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length



PIN FUNCTION DESCRIPTION

Pin	Function	Description
1	Comparator Inverting Input	This is the Uncommitted Comparator Inverting input. It is typically connected to a resistor divider to monitor a voltage.
2	Comparator Noninverting Input	This is the Uncommitted Comparator Noninverting input. It is typically connected to a reference voltage.
3	N.C.	No connection. This pin is not internally connected.
4, 5, 12, 13	Gnd	These pins are the control circuit grounds and are connected to the source and load ground returns. They are part of the IC lead frame and can be used for heatsinking.
6	Comparator Output	This is the Uncommitted Comparator output. It is an open collector sink–only output requiring a pull–up resistor.
7	Reset	This is the Reset Comparator output. It is an open collector sink–only output requiring a pull–up resistor.
8	Power Warning	This is the Power Warning Comparator output. It is an open collector sink–only output requiring a pull–up resistor.
9	Power Sense	This is the Power Warning Comparator noninverting input. It is typically connected to a resistor divider to monitor the input power source voltage.
10	Hysteresis Adjust	The Power Warning Comparator hysteresis is programmed by a resistor connected from this pin to ground.
11	Regulator Output	This is the 5.0 V Regulator output.
14	V_{CC}	This pin is the positive supply input of the control IC.
15	Chip Disable	This input is used to switch the IC into a standby mode turning off all outputs.
16	V_{ref}	This is the 2.6 V Reference output. It is intended to be used in conjunction with the Power Warning and Uncommitted comparators.

OPERATING DESCRIPTION

The MC34160 series is a monolithic voltage regulator and supervisory circuit containing many of the necessary monitoring functions required in microprocessor based systems. It is specifically designed for appliance and industrial applications, offering the designer a cost effective solution with minimal external components. These devices are specified for operation over an input voltage of 7.0 V to 40 V, and with a junction temperature of –40° to +150°C. A typical microprocessor application is shown in Figure 10.

Regulator

The 5.0 V regulator is designed to source in excess of 100 mA output current and is short circuit protected. The output has a guaranteed tolerance of ±5.0% over line, load, and temperature. Internal thermal shutdown circuitry is included to limit the maximum junction temperature to a safe level. When activated, typically at 170°C, the regulator output turns off.

In specific situations a combination of input and output bypass capacitors may be required for regulator stability. If the regulator is located an appreciable distance (≥ 4″) from the supply filter, an input bypass capacitor (C_{in}) of 0.33 μF or greater is suggested. Output capacitance values of less than 5.0 nF may cause regulator instability at light load (≤ 1.0 mA) and cold temperature. An output bypass capacitor of 0.1 μF or greater is recommended to ensure stability under all load conditions. The capacitors selected must provide good high frequency characteristics.

Good construction techniques should be used to minimize ground loops and lead resistance drops since the regulator does not have external sense inputs.

Reference

The 2.6 V bandgap reference is short circuit protected and has a guaranteed output tolerance of ±5.0% over line, load, and temperature. It is intended to be used in conjunction with the Power Warning and Uncommitted comparator. The reference can source in excess of 2.0 mA and sink a maximum of 10 μA. For additional current sinking capability, an external load resistor to ground must be used.

Reference biasing is internally derived from either V_{CC} or V_O, allowing proper operation if either drops below nominal.

Chip Disable

This input is used to switch the IC into a standby mode. When activated, internal biasing for the entire die is removed causing all outputs to turn off. This reduces the power supply current (I_{CC}) to less than 0.3 mA.

Comparators

Three separate comparators are incorporated for voltage monitoring. Their outputs can provide diagnostic information to the microprocessor, preventing system malfunctions.

The Reset Comparator Inverting Input is internally connected to the 2.6 V reference while the Noninverting Input monitors V_O. The Reset Output is active low when V_O falls approximately 180 mV below its regulated voltage. To prevent erratic operation when crossing the comparator threshold, 70 mV of hysteresis is provided.

The Power Warning Comparator is typically used to detect an impending loss of system power. The Inverting Input is internally connected to the reference, fixing the threshold at 2.6 V. The input power source V_{in} is monitored by the Noninverting Input through the R_1/R_2 divider (Figure 10). This input features an adjustable 10 μA to 50 μA current sink I_H that is programmed by the value selected for resistor R_H. A default current of 6.5 μA is provided if R_H is omitted. When the comparator input falls below 2.6 V, the current sink is activated. This produces hysteresis if V_{in} is monitored through a series resistor (R_1). The comparator thresholds are defined as follows:

$$V_{th(lower)} = V_{ref}\left(1 + \frac{R1}{R2}\right) - I_{IB}\,R_1$$

$$V_{th(upper)} = V_{ref}\left(1 + \frac{R1}{R2}\right) + I_H\,R_1$$

The nominal hysteresis current I_H equals 1.2 V/R_H (Figure 4).

The Uncommitted Comparator can be used to synchronize the microprocessor with the ac line signal for timing functions, or for synchronous load switching. It can also be connected as a line loss detector as shown in Figure 11. The comparator contains 200 mV of hysteresis preventing erractic output behavior when crossing the input threshold.

The Power Warning and Uncommitted Comparators each have a transistor base–emitter connected across their inputs. The base input normally connects to a voltage reference while the emitter input connects to the voltage to be monitored. The transistor limits the negative excursion on the emitter input to – 0.7 V below the base input by supply current from V_{CC}. This clamp current will prevent forward biasing the IC substrate. Zener diodes are connected to the comparator inputs to enhance the ICs electrostatic discharge capability. Resistors R_1 and R_{in} must limit the input current to a maximum of ±2.0 mA.

Each comparator output consists of an open collector NPN transistor capable of sinking 2.0 mA with a saturation voltage less than 0.4 V, and standing off 40 V with minimal leakage. Internal bias for the Reset and Power Warning Comparators is derived from either V_{CC} or the regulator output to ensure functionality when either is below nominal.

Heat Tab Package

The MC34160 is contained in a 16 lead plastic dual–in–line package in which the die is mounted on a special Heat Tab copper alloy lead frame. This tab consists of the four center ground pins that are specifically designed to improve thermal conduction from the die to the surrounding air. The pictorial in Figure 8 shows a simple but effective method of utilizing the printed circuit board medium as a heat dissipator by soldering these tabs to an adequate area of copper foil. This permits the use of standard board layout and mounting practices while having the ability to more than halve the junction to air thermal resistance. The example and graph are for a symmetrical layout on a single sided board with one ounce per square foot copper.

Figure 10. Typical Microprocessor Application

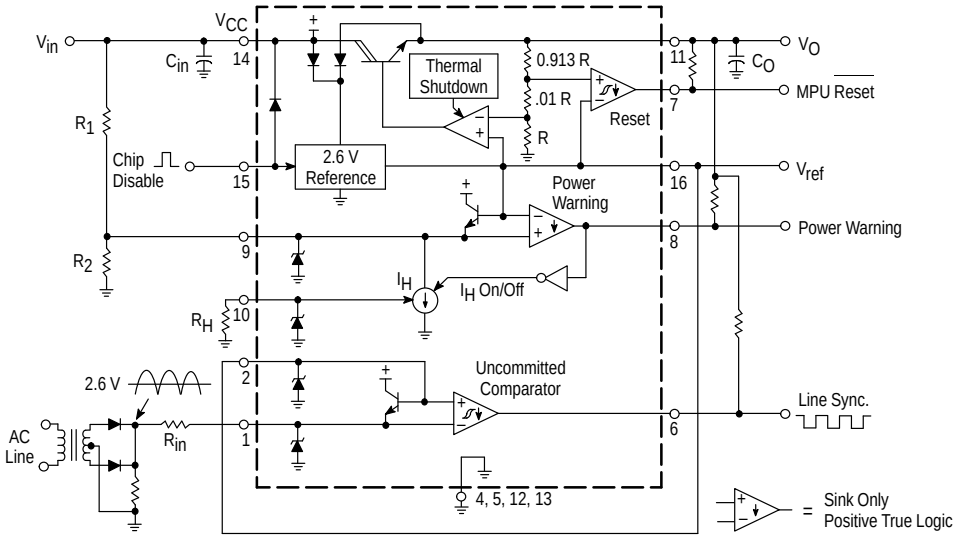


Figure 11. Line Loss Detector Application

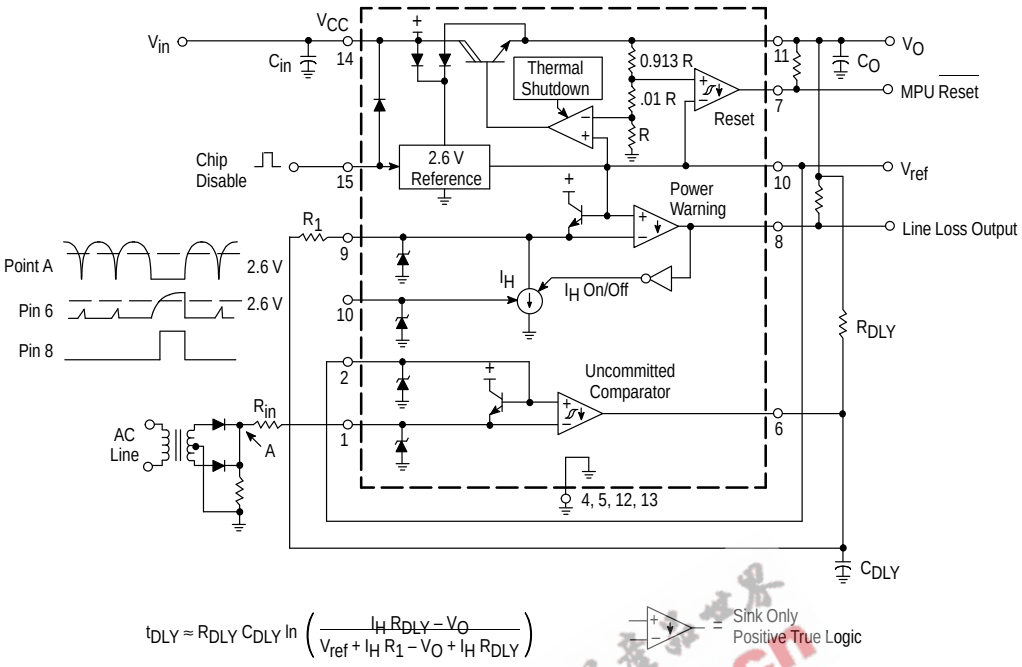
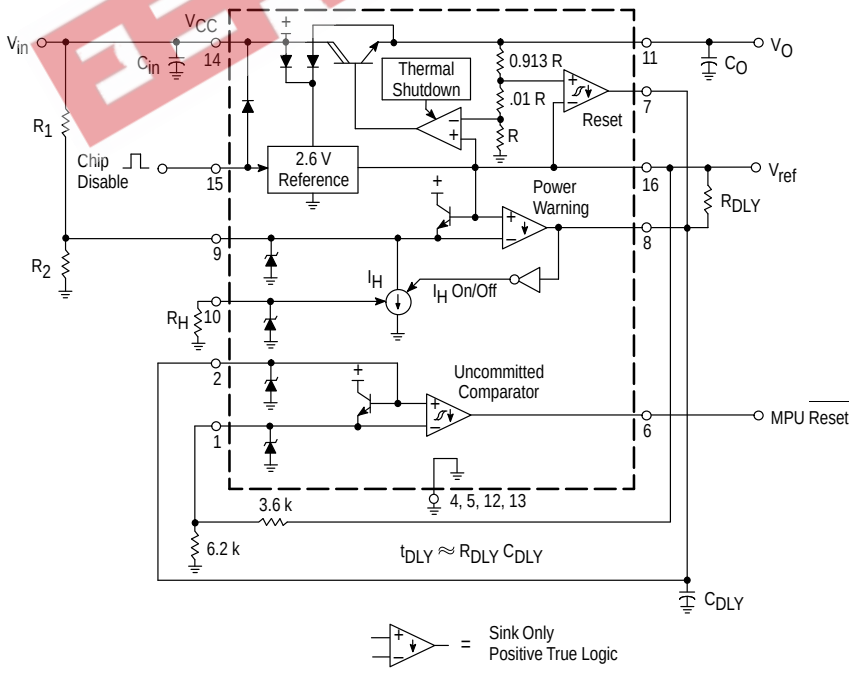
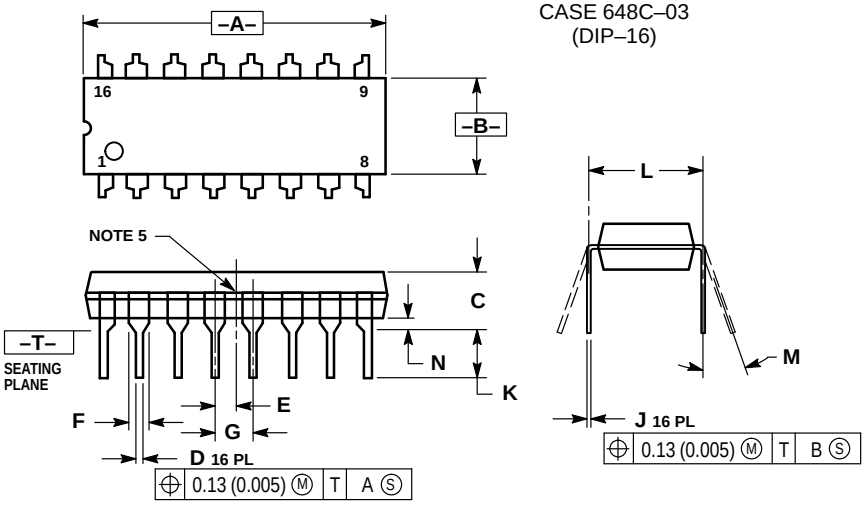


Figure 12. Time Delayed Microprocessor Reset



OUTLINE DIMENSIONS

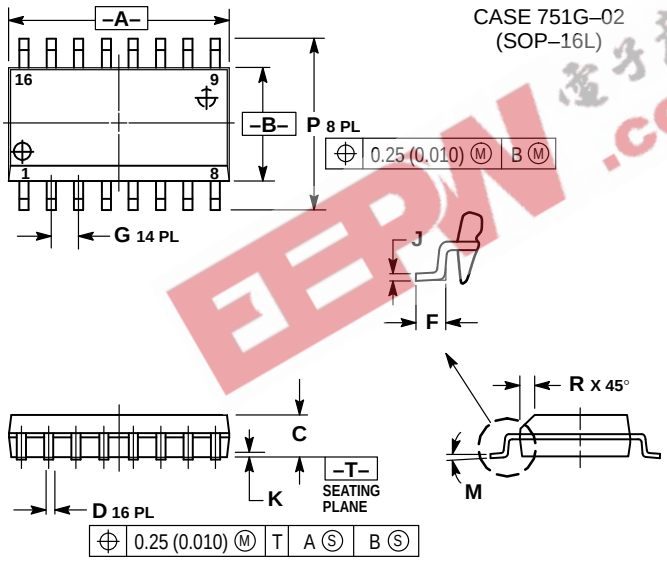
P SUFFIX
PLASTIC PACKAGE
CASE 648C–03
(DIP–16)



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. INTERNAL LEAD CONNECTION, BETWEEN 4 AND 5, 12 AND 13.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.740	0.840	18.80	21.34
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
E	0.050 BSC		1.27 BSC	
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.300 BSC		7.62 BSC	
M	0°	10°	0°	10°
N	0.015	0.040	0.39	1.01

DW SUFFIX
PLASTIC PACKAGE
CASE 751G–02
(SOP–16L)



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 0.13 (0.005) TOTAL IN EXCESS OF D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	10.15	10.45	0.400	0.411
B	7.40	7.60	0.292	0.299
C	2.35	2.65	0.093	0.104
D	0.35	0.49	0.014	0.019
F	0.50	0.90	0.020	0.035
G	1.27 BSC		0.050 BSC	
J	0.25	0.32	0.010	0.012
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	10.05	10.55	0.395	0.415
R	0.25	0.75	0.010	0.029

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