MOTOROLA

MC34164
MC33164

Micropower Undervoltage Sensing Circuits

The MC34164 series are undervoltage sensing circuits specifically designed for use as reset controllers in portable microprocessor based systems where extended battery life is required. These devices offer the designer an economical solution for low voltage detection with a single external resistor. The MC34164 series features a bandgap reference, a comparator with precise thresholds and built–in hysteresis to prevent erratic reset operation, an open collector reset output capable of sinking in excess of 6.0 mA, and guaranteed operation down to 1.0 V input with extremely low standby current. These devices are packaged in 3–pin TO–226AA, 8–pin SO–8 and Micro–8 surface mount packages.

Applications include direct monitoring of the 3.0 or 5.0 V MPU/logic power supply used in appliance, automotive, consumer, and industrial equipment.

- Temperature Compensated Reference
- Monitors 3.0 V (MC34164–3) or 5.0 V (MC34164–5) Power Supplies
- Precise Comparator Thresholds Guaranteed Over Temperature
- Comparator Hysteresis Prevents Erratic Reset
- Reset Output Capable of Sinking in Excess of 6.0 mA
- Internal Clamp Diode for Discharging Delay Capacitor
- Guaranteed Reset Operation With 1.0 V Input
- Extremely Low Standby Current: As Low as 9.0 μA
- Economical TO–226AA, SO–8 and Micro–8 Surface Mount Packages

MICROPOWER UNDERVOLTAGE SENSING CIRCUITS
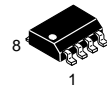
SEMICONDUCTOR
TECHNICAL DATA

P SUFFIX
PLASTIC PACKAGE
CASE 29
(TO–226AA)
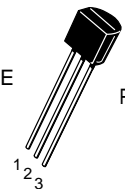
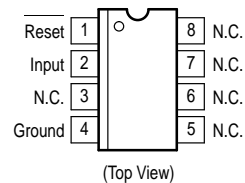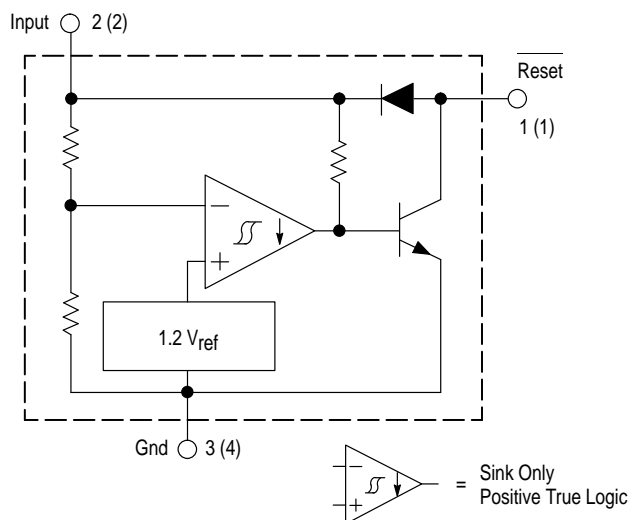Pin 1. Reset
2. Input
3. Ground

D SUFFIX
PLASTIC PACKAGE
CASE 751
(SO–8)

DM SUFFIX
PLASTIC PACKAGE
CASE 846A
(Micro–8)

Reset	1		8	N.C.
Input	2		7	N.C.
N.C.	3		6	N.C.
Ground	4		5	N.C.

(Top View)

Representative Block Diagram

Input ◯ 2 (2)

Reset

1 (1)

1.2 V_ref

Gnd ◯ 3 (4)

= Sink Only
Positive True Logic

Pin numbers adjacent to terminals are for the 3–pin TO–226AA package.
Pin numbers in parenthesis are for the 8–lead packages.

This device contains 28 active transistors.

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC34164D–3		SO–8
MC34164D–5		
MC34164DM–3	T_A = 0° to +70°C	Micro–8
MC34164DM–5		
MC34164P–3		TO–226AA
MC34164P–5		
MC33164D–3		SO–8
MC33164D–5		
MC33164DM–3	T_A = –40° to +125°C	Micro–8
MC33164DM–5		
MC33164P–3		TO–226AA
MC33164P–5		

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Rev 1

MC34164 MC33164

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Input Supply Voltage	V_{in}	−1.0 to 12	V
Reset Output Voltage	V_O	−1.0 to 12	V
Reset Output Sink Current	I_{Sink}	Internally Limited	mA
Clamp Diode Forward Current, Pin 1 to 2 (Note 1)	I_F	100	mA

Power Dissipation and Thermal Characteristics
  P Suffix, Plastic Package
    Maximum Power Dissipation @ T_A = 25°C
    Thermal Resistance, Junction–to–Air
  D Suffix, Plastic Package
    Maximum Power Dissipation @ T_A = 25°C
    Thermal Resistance, Junction–to–Air
  DM Suffix, Plastic Package
    Maximum Power Dissipation @ T_A = 25°C
    Thermal Resistance, Junction–to–Air
	P_D
	$R_{\theta JA}$
	
	P_D
	$R_{\theta JA}$
	
	P_D
	$R_{\theta JA}$
		
		700
		178
		
		700
		178
		
		520
		240
			
			mW
			°C/W
			
			mW
			°C/W
			
			mW
			°C/W

Operating Junction Temperature	T_J	+150	°C

Operating Ambient Temperature Range
  MC34164 Series
  MC33164 Series
	T_A	
		0 to +70
		− 40 to + 85
			°C

Storage Temperature Range	T_{stg}	− 65 to +150	°C

NOTE: ESD data available upon request.

MC34164–3, MC33164–3 SERIES

ELECTRICAL CHARACTERISTICS (For typical values T_A = 25°C, for min/max values T_A is the operating ambient temperature range that applies [Notes 2 & 3], unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
COMPARATOR					

Threshold Voltage
  High State Output (V_{in} Increasing)
  Low State Output (V_{in} Decreasing)
  Hysteresis (I_{Sink} = 100 µA)
	
	V_{IH}
	V_{IL}
	V_H
		
		2.55
		2.55
		0.03
			
			2.71
			2.65
			0.06
				
				2.80
				2.80
				–
					V

RESET OUTPUT					

Output Sink Saturation
  (V_{in} = 2.4 V, I_{Sink} = 1.0 mA)
  (V_{in} = 1.0 V, I_{Sink} = 0.25 mA)
	V_{OL}	
		–
		–
			
			0.14
			0.1
				
				0.4
				0.3
					V

Output Sink Current (V_{in}, Reset = 2.4 V)	I_{Sink}	6.0	12	30	mA

Output Off–State Leakage
  (V_{in}, Reset = 3.0 V)
  (V_{in}, Reset = 10 V)
	$I_{R(leak)}$	
		–
		–
			
			0.02
			0.02
				
				0.5
				1.0
					µA

Clamp Diode Forward Voltage, Pin 1 to 2 (I_F = 5.0 mA)	V_F	6.0	0.9	1.2	V
TOTAL DEVICE					
Operating Input Voltage Range	V_{in}	1.0 to 10	–	–	V

Quiescent Input Current
  V_{in} = 3.0 V
  V_{in} = 6.0 V
	I_{in}	
		–
		–
			
			9.0
			24
				
				15
				40
					µA

NOTES: 1. Maximum package power dissipation limits must be observed.
  2. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient as possible.
  3. T_{low} = 0°C for MC34164 T_{high} = + 70°C for MC34164
       − 40°C for MC33164   = + 85°C for MC33164

MC34164–5, MC33164–5 SERIES

ELECTRICAL CHARACTERISTICS (For typical values T_A = 25°C, for min/max values T_A is the operating ambient temperature range that applies [Notes 2 & 3], unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
COMPARATOR					
Threshold Voltage					V
High State Output (V_{in} Increasing)	V_{IH}	4.15	4.33	4.45	
Low State Output (V_{in} Decreasing)	V_{IL}	4.15	4.27	4.45	
Hysteresis (I_{Sink} = 100 µA)	V_H	0.02	0.09	–	
RESET OUTPUT					
Output Sink Saturation	V_{OL}				V
(V_{in} = 4.0 V, I_{Sink} = 1.0 mA)		–	0.14	0.4	
(V_{in} = 1.0 V, I_{Sink} = 0.25 mA)		–	0.1	0.3	
Output Sink Current (V_{in}, Reset = 4.0 V)	I_{Sink}	7.0	20	50	mA
Output Off–State Leakage	$I_{R(leak)}$				µA
(V_{in}, Reset = 5.0 V)		–	0.02	0.5	
(V_{in}, Reset = 10 V)		–	0.02	2.0	
Clamp Diode Forward Voltage, Pin 1 to 2 (I_F = 5.0 mA)	V_F	0.6	0.9	1.2	V
TOTAL DEVICE					
Operating Input Voltage Range	V_{in}	1.0 to 10	–	–	V
Quiescent Input Current	I_{in}				µA
V_{in} = 5.0 V		–	12	20	
V_{in} = 10 V		–	32	50	

NOTES: 2. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient as possible.

    3. T_{low} = 0°C for MC34164 T_{high} = + 70°C for MC34164
          – 40°C for MC33164   = + 85°C for MC33164

Figure 1. MC3X164–3 Reset Output Voltage versus Input Voltage

R_L = 82 k to V_{in}
T_A = 25°C
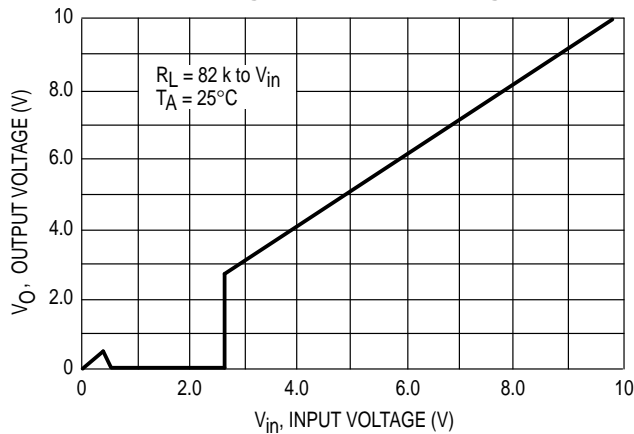
Figure 2. MC3X164–5 Reset Output Voltage versus Input Voltage

R_L = 82 k to V_{in}
T_A = 25°C
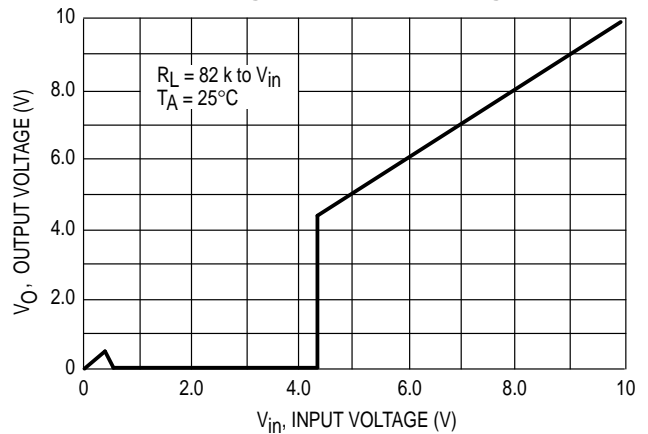
**Figure 3. MC3X164–3 Reset Output
Voltage versus Input Voltage**

R_L = 82 k to V_{in}
T_A = 25°C
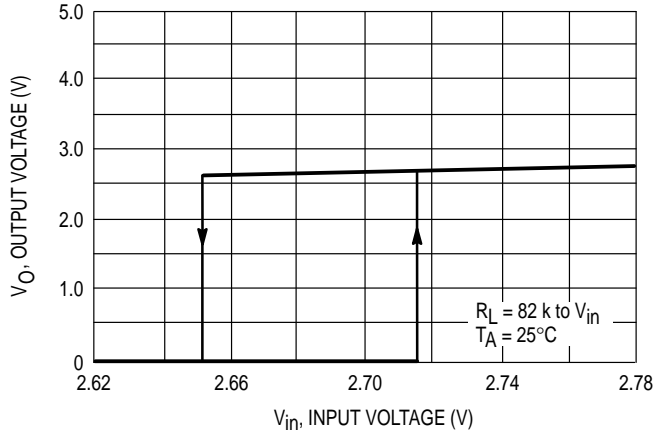
**Figure 4. MC3X164–5 Reset Output
Voltage versus Input Voltage**

R_L = 82 k to V_{in}
T_A = 25°C
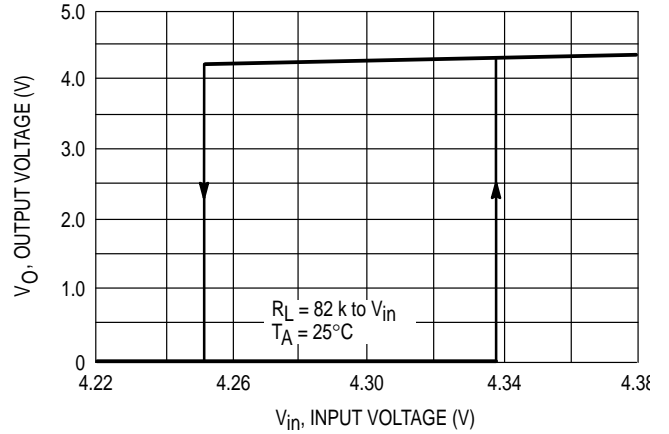
**Figure 5. MC3X164–3 Comparator Threshold
Voltage versus Temperature**

Upper Threshold
High State Output

Lower Threshold
Low State Output
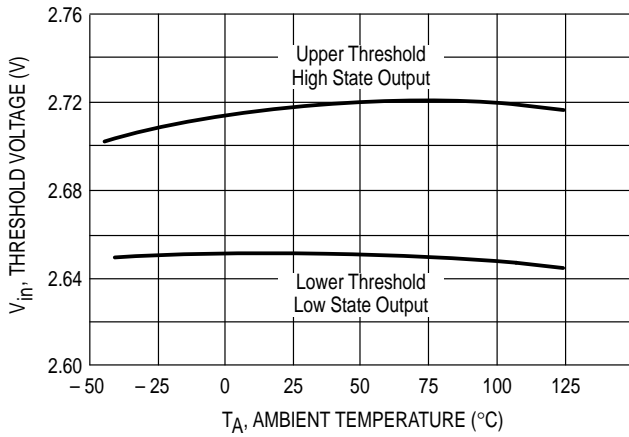
**Figure 6. MC3X164–5 Comparator Threshold
Voltage versus Temperature**

Upper Threshold
High State Output

Lower Threshold
Low State Output
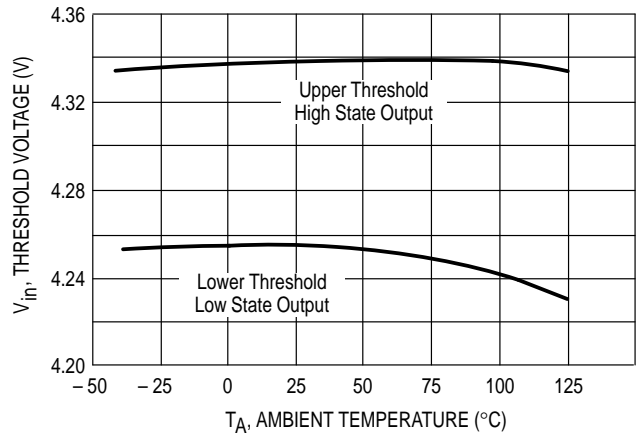
**Figure 7. MC3X164–3 Input Current
versus Input Voltage**

T_A = 25°C

T_A = 0°C

T_A = 70°C
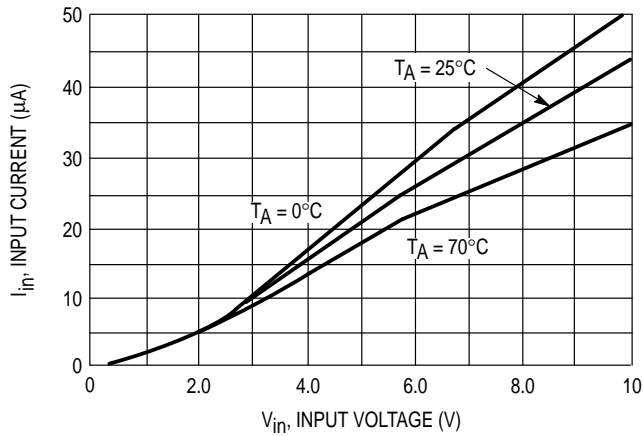
**Figure 8. MC3X164–5 Input Current
versus Input Voltage**

T_A = 25°C

T_A = 0°C

T_A = 70°C
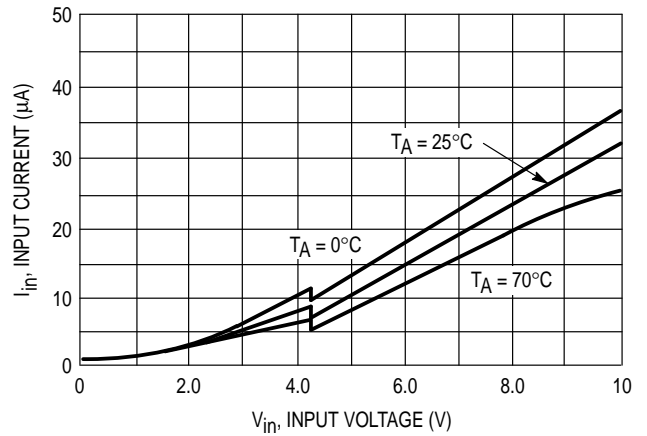
**Figure 9. MC3X164–3 Reset Output
Saturation versus Sink Current**
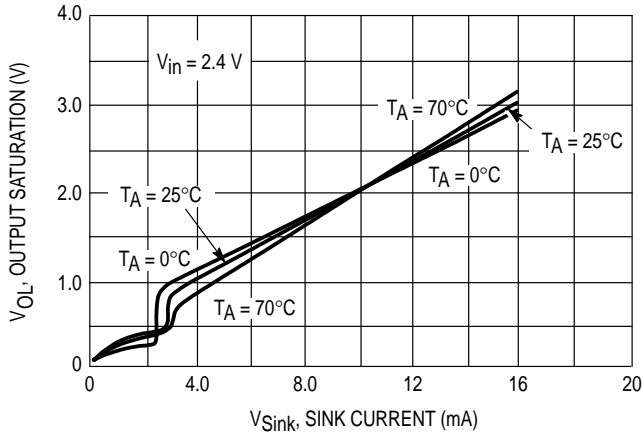
**Figure 10. MC3X164–5 Reset Output
Saturation versus Sink Current**
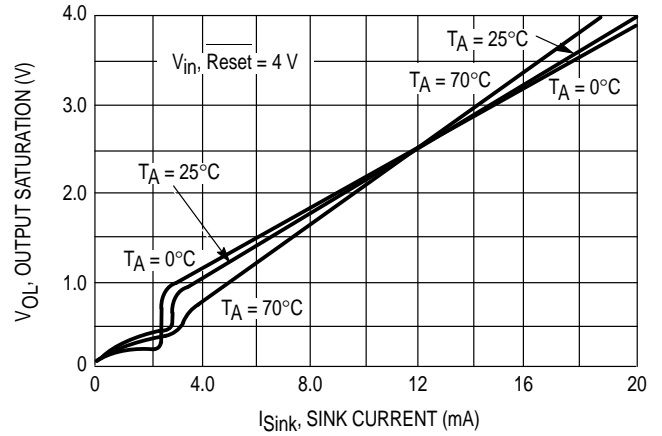
**Figure 11. Clamp Diode Forward Current
versus Voltage**
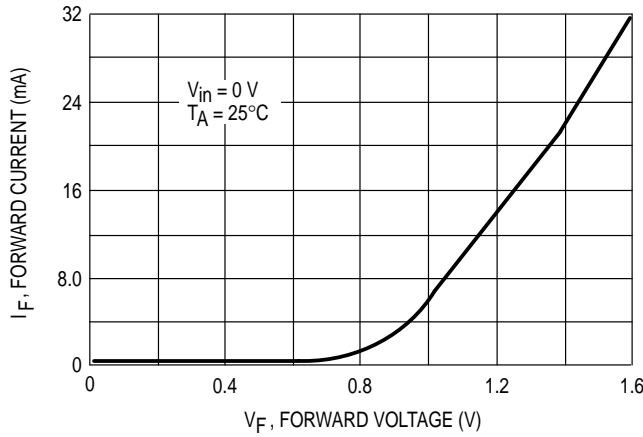
**Figure 12. Reset Delay Time
(MC3X164–5 Shown)**
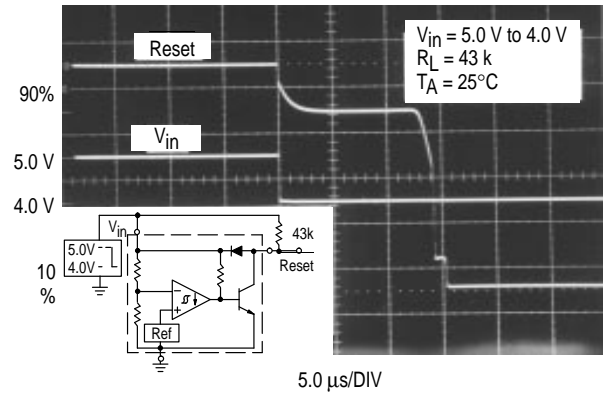
Figure 13. Low Voltage Microprocessor Reset


$$t_{DLY} = R C_{DLY} \ln \left(\frac{1}{1 - \dfrac{V_{th(MPU)}}{V_{in}}} \right)$$
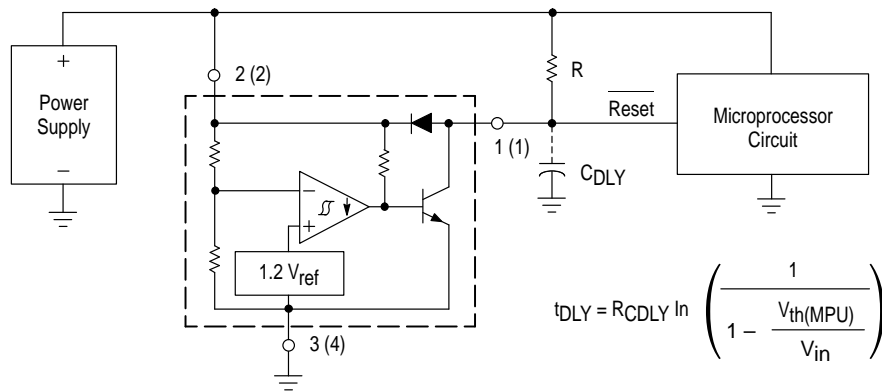
A time delayed reset can be accomplished with the addition of C_{DLY}. For systems with extremely fast power supply rise times (< 500 ns) it is recommended that the RCDLY time constant be greater than 5.0 μs. $V_{th(MPU)}$ is the microprocessor reset input threshold.

**Figure 14. Low Voltage Microprocessor Reset With Additional Hysteresis
(MC3X164–5 Shown)**
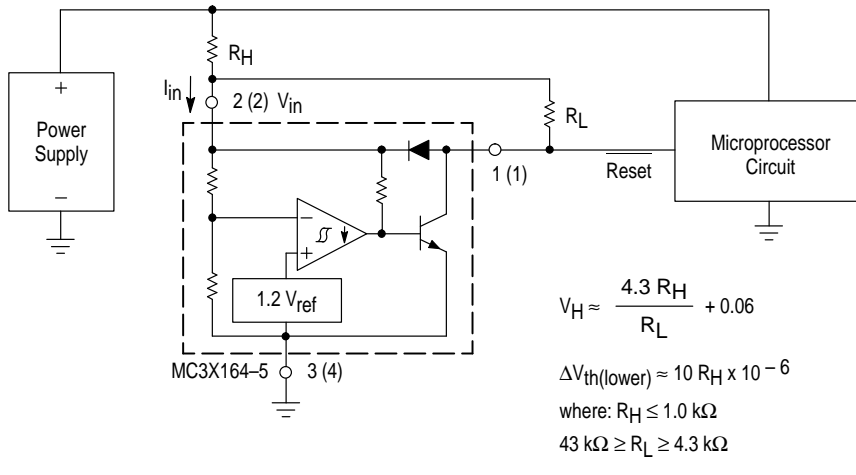
Test Data			
V_H (mV)	ΔV_{th} (mV)	R_H (Ω)	R_L (kΩ)
60	0	0	43
103	1.0	100	10
123	1.0	100	6.8
160	1.0	100	4.3
155	2.2	220	10
199	2.2	220	6.8
280	2.2	220	4.3
262	4.7	470	10
306	4.7	470	8.2
357	4.7	470	6.8
421	4.7	470	5.6
530	4.7	470	4.3

$$V_H \approx \frac{4.3\ R_H}{R_L} + 0.06$$

$$\Delta V_{th(lower)} \approx 10\ R_H \times 10^{-6}$$

where: $R_H \leq 1.0$ kΩ

43 k$\Omega \geq R_L \geq 4.3$ kΩ

Comparator hysteresis can be increased with the addition of resistor R_H. The hysteresis equation has been simplified and does not account for the change of input current I_{in} as V_{in} crosses the comparator threshold (Figure 8). An increase of the lower threshold $\Delta V_{th(lower)}$ will be observed due to I_{in} which is typically 10 μA at 4.3 V. The equations are accurate to $\pm$10% with R_H less than 1.0 kΩ and R_L between 4.3 kΩ and 43 kΩ.
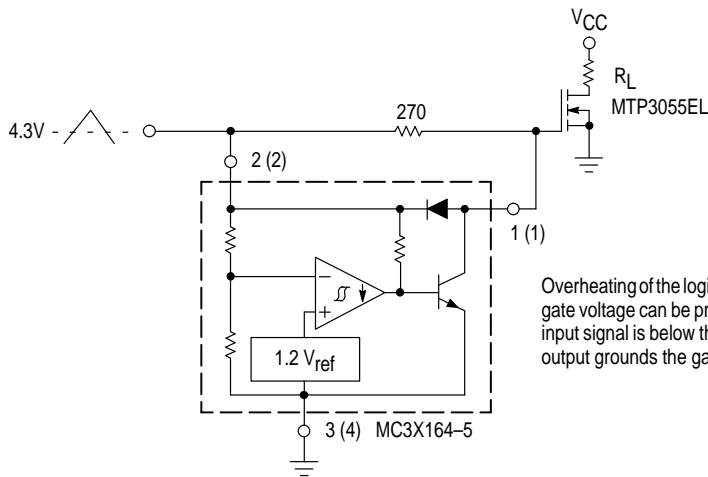
Figure 15. Voltage Monitor
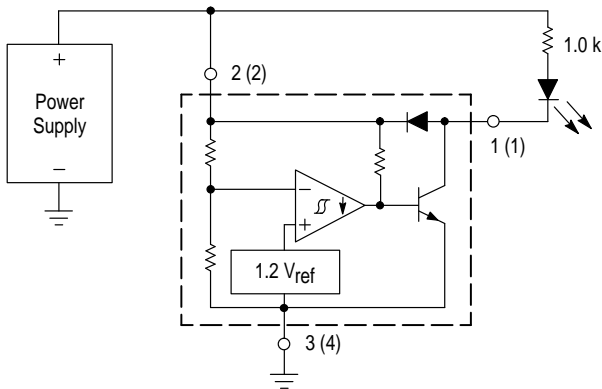
Figure 16. Solar Powered Battery Charger
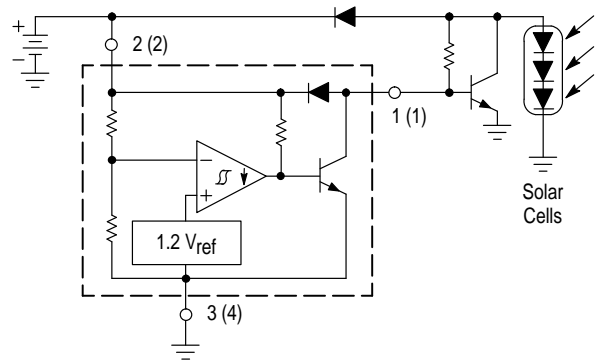
Figure 17. MOSFET Low Voltage Gate Drive Protection Using the MC3X164–5
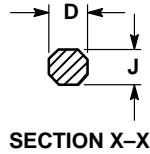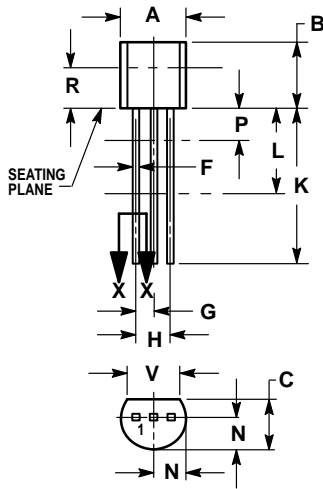

Overheating of the logic level power MOSFET due to insufficient gate voltage can be prevented with the above circuit. When the input signal is below the 4.3 V threshold of the MC3X164–5, its output grounds the gate of the L^2 MOSFET.

OUTLINE DIMENSIONS

P SUFFIX
PLASTIC PACKAGE
CASE 29–04
(TO–226AA)
ISSUE AD

SECTION X–X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. DIMENSION F APPLIES BETWEEN P AND L. DIMENSION D AND J APPLY BETWEEN L AND K MINIMUM. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| DIM	INCHES MIN	INCHES MAX	MILLIMETERS MIN	MILLIMETERS MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.022	0.41	0.55
F	0.016	0.019	0.41	0.48
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	—	12.70	—
L	0.250	—	6.35	—
N	0.080	0.105	2.04	2.66
P	—	0.100	—	2.54
R	0.115	—	2.93	—
V	0.135	—	3.43	—

D SUFFIX
PLASTIC PACKAGE
CASE 751–05
(SO–8)
ISSUE P
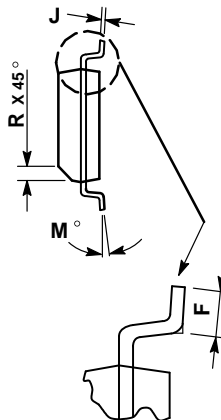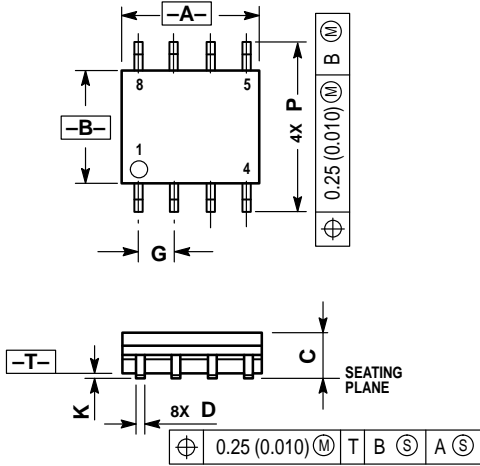
NOTES:
1. DIMENSIONS A AND B ARE DATUMS AND T IS A DATUM SURFACE.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3. DIMENSIONS ARE IN MILLIMETER.
4. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
6. DIMENSION D DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS MIN	MILLIMETERS MAX
A	4.80	5.00
B	3.80	4.00
C	1.35	1.75
D	0.35	0.49
F	0.40	1.25
G	1.27 BSC	
J	0.18	0.25
K	0.10	0.25
M	0 °	7 °
P	5.80	6.20
R	0.25	0.50

OUTLINE DIMENSIONS

DM SUFFIX
PLASTIC PACKAGE
CASE 846A–02
(Micro–8)
ISSUE B
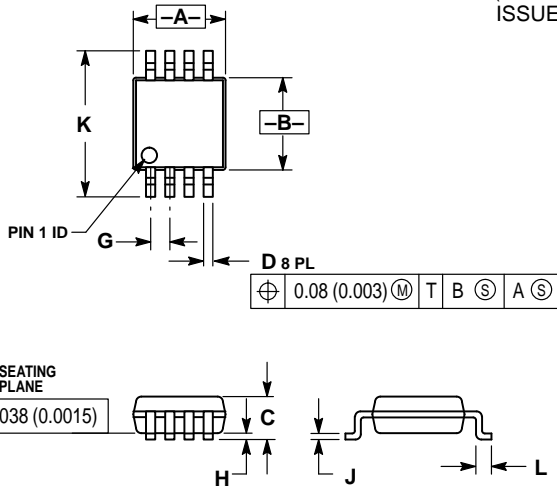
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION D DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	2.90	3.10	0.114	0.122
B	2.90	3.10	0.114	0.122
C	—	1.10	—	0.043
D	0.25	0.40	0.010	0.016
G	0.65 BSC		0.026 BSC	
H	0.05	0.15	0.002	0.006
J	0.13	0.23	0.005	0.009
K	4.75	5.05	0.187	0.199
L	0.40	0.70	0.016	0.028