MC33465

## Micropower Undervoltage Sensing Circuits with Programmable Output Delay

The MC33465 series are micropower undervoltage sensing circuits that are specifically designed for use with battery powered microprocessor based systems, where extended battery life is required. A choice of several threshold voltages from 0.9 V to 4.5 V are available. This device features a very low quiescent bias current of 1.0 μA typical.

The MC33465 series features a highly accurate voltage reference, a comparator with precise thresholds and built–in hysteresis to prevent erratic reset operation, a choice of output configurations between open drain or complementary, a time delayed output, which can be programmed by the system designer, and guaranteed operation below 1.0 V with extremely low standby current. This device is available in a SOT–23 5–pin surface mount package.

Applications include direct monitoring of the MPU/logic power supply used in appliance, automotive, industrial and portable equipment.

Features:

- Extremely Low Standby Current of 1.0 μA at V_{in} = 3.5 V
- Wide Input Voltage Range (0.7 V to 10 V)
- Monitors Power Supply Voltages from 1.1 V to 5.0 V
- High Accuracy Detector Threshold (±2.5%)
- Two $\overline{\text{Reset}}$ Output Types (Open Drain or Complementary Drive)
- Programmable Output Delay by External Capacitor (100 ms typ. with 0.15 μF)
- Surface Mount Package (SOT–23 5–Pin)
- Convenient Tape and Reel (3000 per Reel)
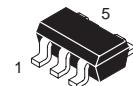
SOT–23–5
N SUFFIX
CASE 1212

PIN CONNECTIONS
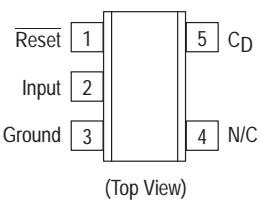
$\overline{\text{Reset}}$	1		5	C_D
Input	2			
Ground	3		4	N/C

(Top View)

Representative Block Diagrams

MC33465N–YYATR
Open Drain Output Configuration
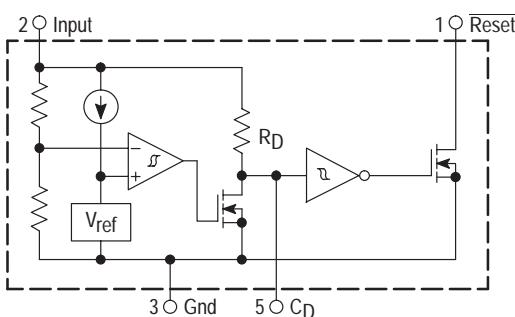
MC33465N–YYCTR
Complementary Output Configuration
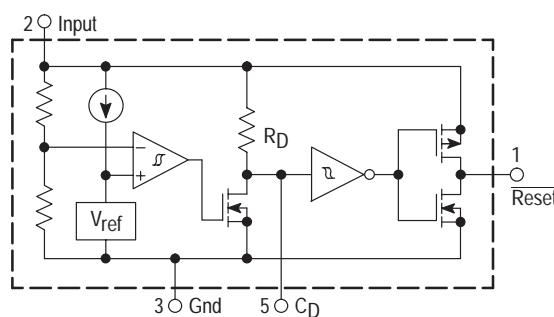
YY Denotes Threshold Voltage

This device contains 28 active transistors.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Input Supply Voltage	V_{in}	0 to 12	V
$\overline{Reset}$ Output Voltage	V_O	−0.3 to 12	V
$\overline{Reset}$ Output Current (Source or Sink)	I_O	70	mA
Power Dissipation and Thermal Characteristics Maximum Power Dissipation at $T_A = 25°C$ Case 1212 (SOT–23) N Suffix	P_D	150	mW
Thermal Resistance, Junction–to–Ambient	$R_{\theta JA}$	667	°C/W
Operating Junction Temperature	T_J	+125	°C
Operating Ambient Temperature	T_A	−40 to +85	°C
Storage Temperature Range	T_{stg}	−40 to +125	°C
Lead Temperature (Soldering)	T_{solder}	260°C, 10 s	

ELECTRICAL CHARACTERISTICS (For all values T_A = 25°C (Note 1), unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
SENSE COMPARATOR					
Threshold Voltage High to Low State Output (V_{in} Decreasing) 09 Suffix 20 Suffix 22 Suffix 27 Suffix 28 Suffix 30 Suffix 32 Suffix 34 Suffix 38 Suffix 43 Suffix 44 Suffix 45 Suffix 46 Suffix 47 Suffix	V_{IL}	 0.878 1.950 2.145 2.633 2.730 2.925 3.120 3.315 3.705 4.193 4.290 4.387 4.485 4.583	 0.9 2.0 2.2 2.7 2.8 3.0 3.2 3.4 3.8 4.3 4.4 4.5 4.6 4.7	 0.922 2.050 2.255 2.767 2.870 3.075 3.280 3.485 3.895 4.407 4.510 4.612 4.715 4.817	V
Threshold Hysteresis (V_{in} Increasing) 09 Suffix 20 Suffix 22 Suffix 27 Suffix 28 Suffix 30 Suffix 32 Suffix 34 Suffix 38 Suffix 43 Suffix 44 Suffix 45 Suffix 46 Suffix 47 Suffix	V_H	 0.027 0.060 0.066 0.081 0.084 0.090 0.096 0.102 0.114 0.129 0.132 0.135 0.138 0.141	 0.045 0.100 0.110 0.135 0.140 0.150 0.160 0.170 0.190 0.215 0.220 0.225 0.230 0.235	 0.063 0.140 0.154 0.189 0.196 0.210 0.224 0.238 0.266 0.301 0.308 0.315 0.322 0.329	V
Threshold Voltage Temperature Coefficient	T_C	–	±100	–	PPM/°C
RESET OUTPUT					
Output Voltage High State (Complementary Output: I_{source} = 1.0 mA) Low State (Complementary or Open Drain Output: I_{sink} = 1.0 mA)	V_{OH} V_{OL}	V_{in} – 2.1 –	V_{in} – 1.0 0.25	V_{in} 0.5	V
Output Sink Current (V_{in} = 1.5 V, V_{OL} = 0.5 V)	I_{OL}	1.0	2.0	–	mA
Output Source Current (V_{in} = 4.5 V, V_{OH} = 2.4 V)	I_{OH}	1.0	2.0	–	mA
DELAY OUTPUT					
Output Sink Current (V_{in} = 1.5 V, V_{OL} = 0.5 V)	I_{OL}	0.2	0.8	–	mA
Delay Resistance	R_D	0.5	1.0	2.0	MΩ
TOTAL DEVICE					
Operating Input Voltage Range	V_{in}	0.8 to 10	–	–	V
Quiescent Input Current V_{in} = 4.34 V V_{in} = 6.50 V	I_{in}	 – –	 5.5 1.3	 11 3.9	μA

NOTE: 1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.

**Figure 1. Reset Low State Sink Current versus Output Voltage**

MC33465N–45ATR
$T_A = 20°C$

$V_{in} = 2.5$ V

2.0 V

1.5 V

I_O, OUTPUT SINK CURRENT (mA)

V_{OL}, LOW STATE OUTPUT VOLTAGE (V)
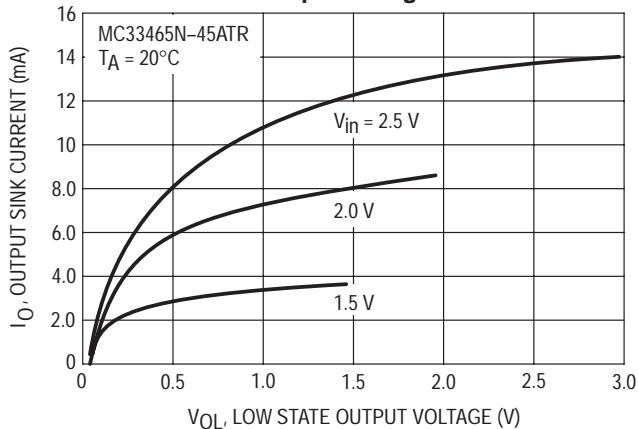
Figure 2. Output Voltage versus Input Voltage

MC33465N–45ATR
470 kΩ Pull–up

30°C

$T_A = -30°C$

$T_A = 25°C$

$T_A = 80°C$

80°C, 20°C

V_O, OUTPUT VOLTAGE (V)
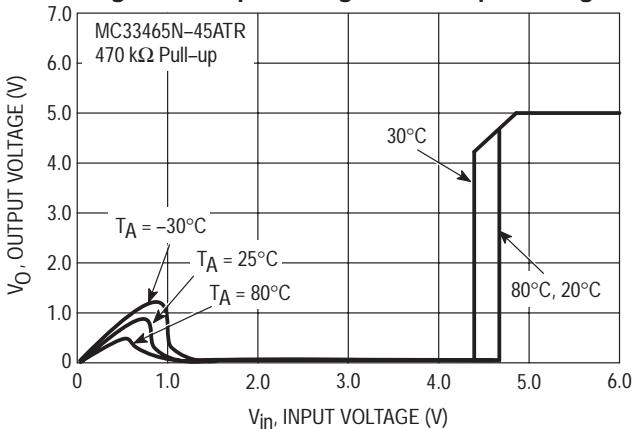
V_{in}, INPUT VOLTAGE (V)

Figure 3. Input Current versus Input Voltage

MC33465N–45ATR

$T_A = 80°C$

$T_A = 25°C$

$T_A = -30°C$

80°C   25°C

−30°C

I_{in}, SUPPLY CURRENT (μA)
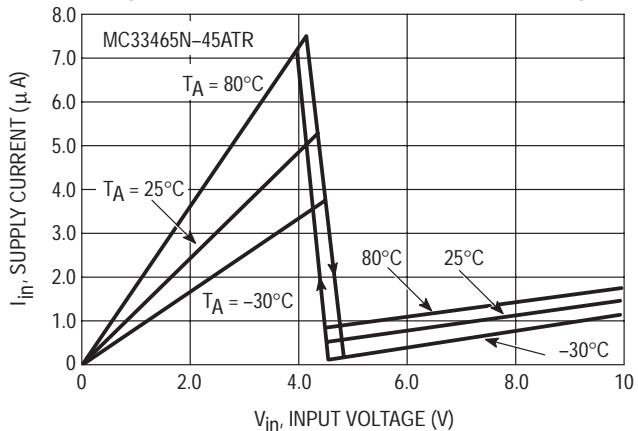
V_{in}, INPUT VOLTAGE (V)

Figure 4. Comparator Input Threshold Voltage versus Temperature

$V_{IL} + V_H$

V_H

V_{IL}

MC33465N–27ATR

V_{in}, INPUT THRESHOLD VOLTAGE (V)

T_A, AMBIENT TEMPERATURE (°C)
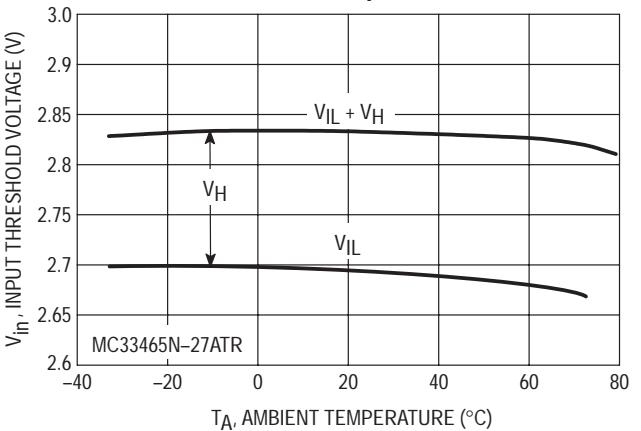
Figure 5. Reset Output Sink Current versus Input Voltage

MC33465N–27ATR
$V_{OL} = 0.5$ V

$T_A = -30°C$

25°C

80°C

I_O, OUTPUT SINK CURRENT (mA)
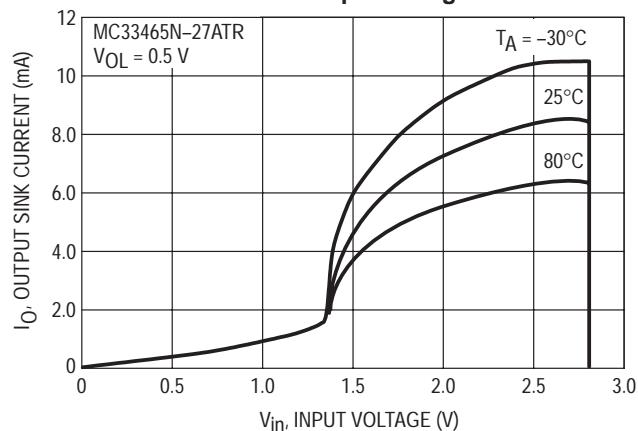
V_{in}, INPUT VOLTAGE (V)

Figure 6. Reset Output Source Current versus Input Voltage

MC33465N–27CTR

$V_{in} - V_O = 2.1$ V

$V_{in} - V_O = 1.5$ V

$V_{in} - V_O = 1.0$ V

$V_{in} - V_O = 0.5$ V

I_O, OUTPUT CURRENT (mA)
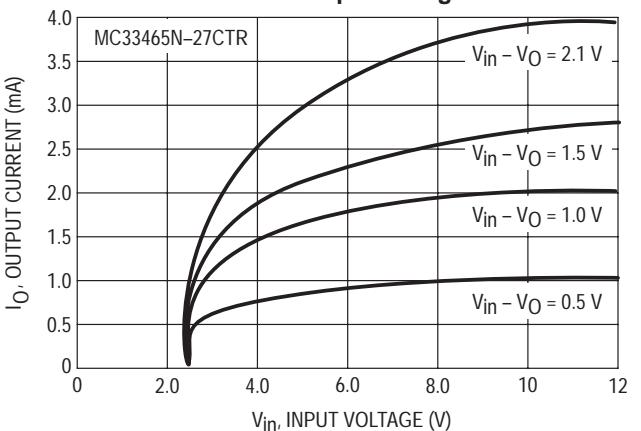
V_{in}, INPUT VOLTAGE (V)

Figure 7. C$_D$ Sink Current versus Input Voltage

C$_D$, SINK CURRENT (mA) vs V$_{in}$, INPUT VOLTAGE (V)

MC33465N–27ATR
V$_{OL}$ = 0.5 V

T$_A$ = –30°C
25°C
80°C
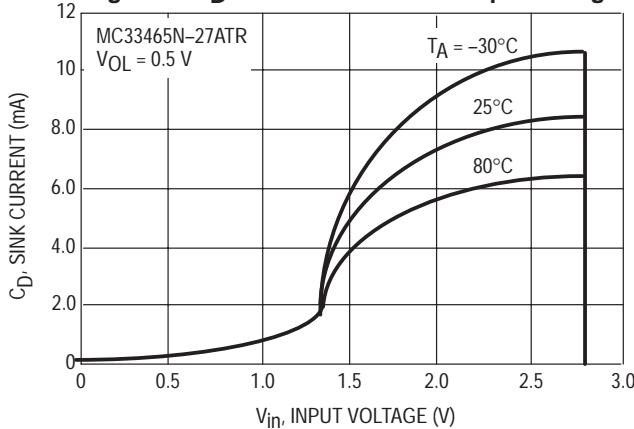
Figure 8. C$_D$ Sink Current versus C$_D$ Voltage

I$_{sink}$, SINK CURRENT (mA) vs V$_{CD}$, VOLTAGE (V)

V$_{in}$ = 2.5 V
V$_{in}$ = 2.0 V
V$_{in}$ = 1.5 V
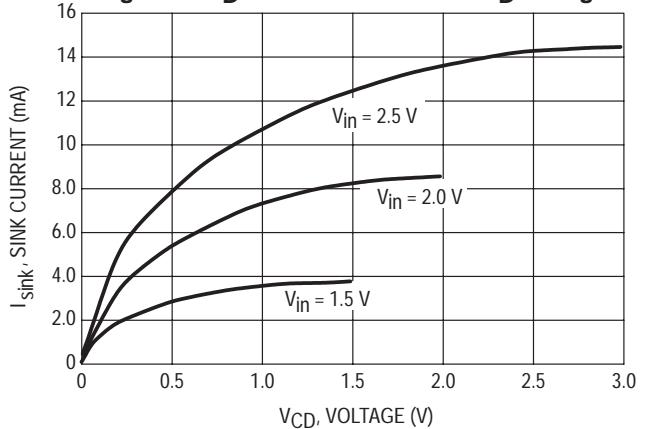
Figure 9. Delay Resistance versus Temperature

R$_D$, DELAY RESISTANCE (MΩ) vs T$_A$, AMBIENT TEMPERATURE (°C)
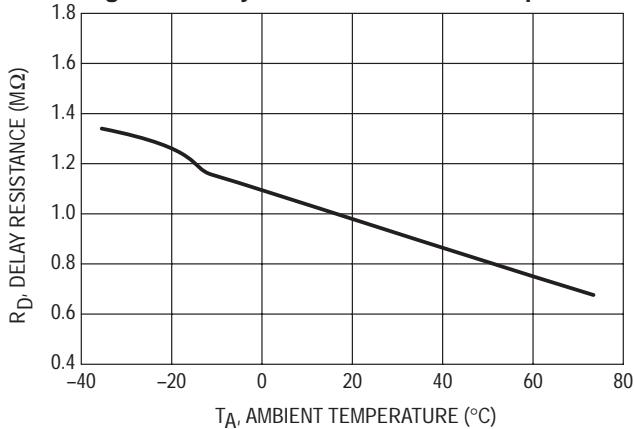
Figure 10. Detector Threshold versus Temperature

V$_{th(D)}$, DETECTOR THRESHOLD VOLTAGE (V) vs T$_A$, AMBIENT TEMPERATURE (°C)

V$_{in}$ = 2.97 V

MC33465N–27ATR
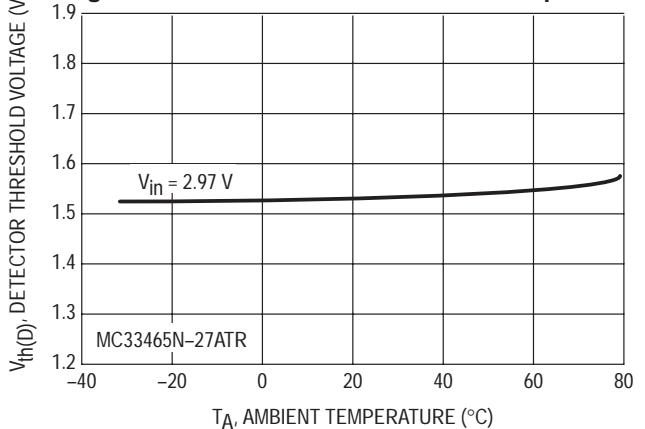
**Figure 11. Output Delay Time versus
Delay Capacitance**

t$_p$, OUTPUT DELAY TIME (ms) vs C$_D$, DELAY CAPACITANCE (μF)

t$_D$: Output Switch
Low to High

t$_{PHL}$: Output Switch
High to Low
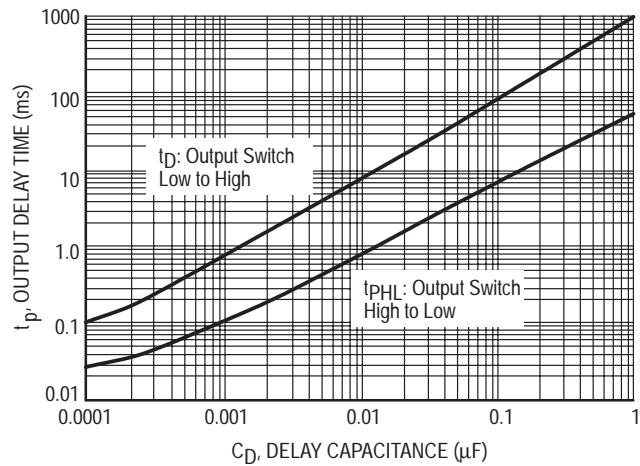
MC33465

## Figure 12. Typical Open Drain Application
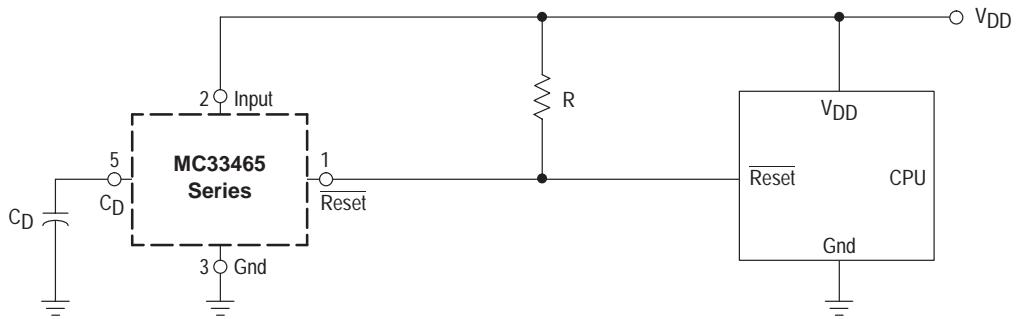
## Figure 13. Typical Complementary Output Application
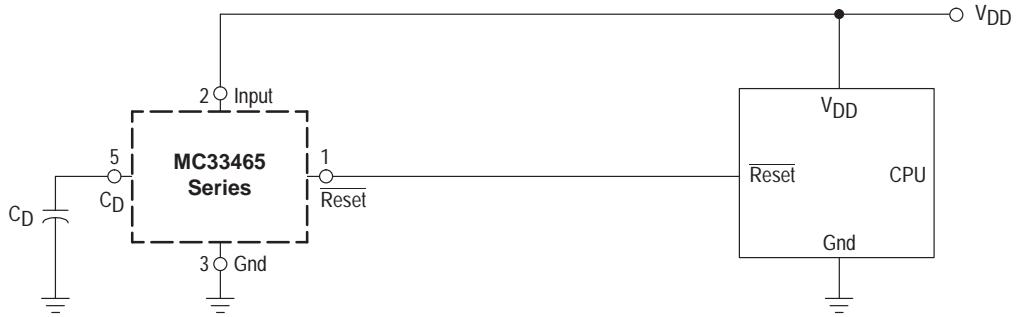
APPLICATION CIRCUIT INFORMATION

The MC33465 series are micropower undervoltage sensing circuits which offer a programmable time delayed output with the choice of either complementary output drive or open drain output configurations. Figure 14 shows the timing relationships between the input voltage and the resulting circuit waveforms. When the input voltage (V_{in}) exceeds the sense comparator threshold, the timing capacitor is allowed to charge through the internal delay resistor. When the output inverting driver threshold is exceeded, the Reset output switches from a logic "0" to a logic "1". The top curve of Figure 11 provides the nominal delay time for a given value of delay capacitance. When V_{in} drops below the comparator threshold minus hysteresis voltage, the delay capacitor discharges. When the capacitance voltage drops below the inverting drive threshold, the output switches from a logic "1" to a logic "0". The bottom curve in Figure 11 provides typical delay time for given delay capacitance values. The inverting driver threshold voltage is typically about $V_{in}/2$, as shown in Figure 10.

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**Figure 14. Timing Waveforms**
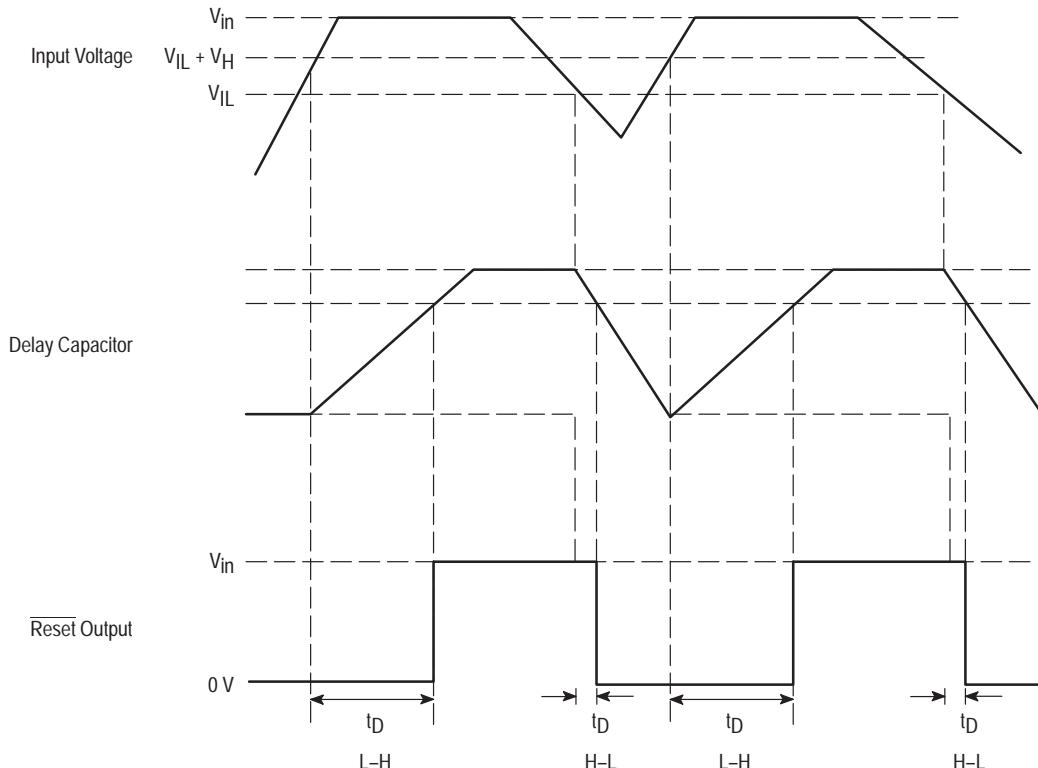
ORDERING INFORMATION

Device	Threshold Voltage	Type	Marking	Package	Package
MC33465N–09ATR	0.9		$\overline{A}9$		
MC33465N–20ATR	2.0		$\overline{C}0$		
MC33465N–22ATR	2.2		$\overline{C}2$		
MC33465N–27ATR	2.7		$\overline{C}7$		
MC33465N–28ATR	2.8		$\overline{D}8$		
MC33465N–30ATR	3.0	Open Drain $\overline{\text{Reset}}$	$\overline{D}0$		
MC33465N–32ATR	3.2		$\overline{D}2$		
MC33465N–34ATR	3.4		$\overline{D}4$	SOT–23 5–Lead	3000 Tape & Reel
MC33465N–38ATR	3.8		$\overline{D}8$		
MC33465N–45ATR	4.5		$\overline{E}5$		
MC33465N–46ATR	4.6		$\overline{E}6$		
MC33465N–47ATR	4.7		$\overline{E}7$		
MC33465N–09CTR	0.9		$9\overline{A}$		
MC33465N–20CTR	2.0		$0\overline{C}$		
MC33465N–27CTR	2.7	Compl. MOS $\overline{\text{Reset}}$	$7\overline{C}$		
MC33465N–30CTR	3.0		$0\overline{D}$		
MC33465N–43CTR	4.3		$3\overline{E}$		
MC33465N–44CTR	4.4		$4\overline{E}$		
MC33465N–45CTR	4.5		$5\overline{E}$		

Other voltages from 0.9 to 6.0 V, in 0.1 V increments, are available. Consult factory for information.

MC33465

PACKAGE DIMENSIONS

(SOT–23)
N SUFFIX
PLASTIC PACKAGE
CASE 1212–01
ISSUE O
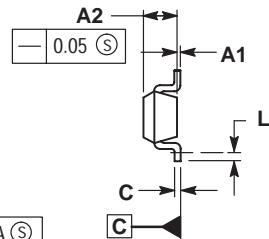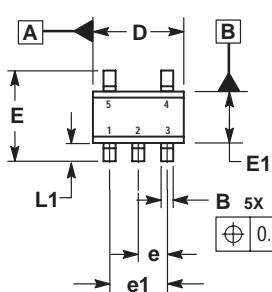
NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DATUM C IS A SEATING PLANE.

DIM	MILLIMETERS	
	MIN	MAX
A1	0.00	0.10
A2	1.00	1.30
B	0.30	0.50
C	0.10	0.25
D	2.80	3.00
E	2.50	3.10
E1	1.50	1.80
e	0.95 BSC	
e1	1.90 BSC	
L	0.20	–––
L1	0.45	0.75

Recommended Footprint for Surface Mount Applications

0.7 MAX.

1.0

2.4

0.95 0.95

1.9

(Unit: mm)

SOT–23–5