

LP265/LP365 Micropower Programmable Quad Comparator

General Description

The LP365 consists of four independent voltage comparators. The comparators can be programmed, four at the same time, for various supply currents, input currents, response times and output current drives. This is accomplished by connecting a single resistor between the V_{CC} and I_{SET} pins.

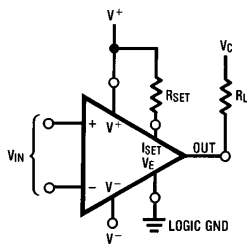
These comparators can be operated from split power supplies or from a single power supply over a wide range of voltages. The input can sense signals at ground level even with single supply operation. The unique output NPN transistor stages are uncommitted to either power supply. They can be connected directly to various logic system supplies so that they are highly flexible to interface with various logic families.

Application areas include battery power circuits, threshold detectors, zero crossing detectors, simple serial A/D converters, VCO, multivibrators, voltage converters, power sequencers, and high performance V/F converters, and RTD linearization.

Features

- Single programming resistor to tailor power consumption, input current, speed and output current drive capability
- Wide single supply voltage range or dual supplies (4 V_{DC} to 36 V_{DC} or $\pm 2.0 V_{DC}$ to $\pm 18 V_{DC}$)
- Low supply current drain (10 μA) and low power consumption (10 μW /comparator) @ $I_{SET} = 0.5 \mu A$ $V_{CC} = 5V_{DC}$
- Uncommitted output stage—selectable output levels
- Output directly compatible with DTL, TTL, CMOS, MOS or other special logic families
- Input common-mode range includes ground
- Differential input voltage equal to the power supply voltage

Typical Connection



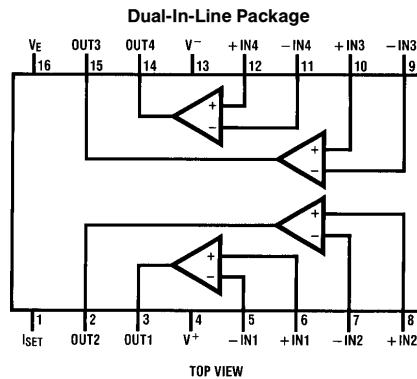
TL/H/5023-1

Programming Equation

$$I_{SET} = \frac{(V^+) - (V^-) - 1.3V}{R_{SET}}$$

$$I_{SUPPLY} \approx 22 \times I_{SET}$$

Connection Diagram



TL/H/5023-2

Order Number LP365M, LP365AN or LP365N
See NS Package Numbers M16A or N16A

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

| | |
|---|---|
| Supply Voltage | 36 V _{DC} or ± 18 V _{DC} |
| Differential Input Voltage | ± 36 V _{DC} |
| Input Voltage (Note 1) | −0.3V to +36 V _{DC} |
| Output Short Circuit to V _E (Note 2) | Continuous |
| V _{OUT} with Respect to V _E | V _E − 7V ≤ V _{OUT} ≤ V _E + 36V |
| ESD Tolerance (Note 10) | 2000V |

Power Dissipation (Note 3)

T_j Max

θ_{jA}

Lead Temp.

(Soldering—10 sec.)

(Vapor Phase—60 sec.)

(Infrared—15 sec.)

Operating Temp. Range LP365:

Storage Temp. Range

M Package **N Package**

500 mW 500 mW

115°C 115°C

115°C/W 90°C/W

260°C

215°C

220°C

0°C ≤ T_A ≤ +70°C

−40°C ≤ T_A ≤ +150°C

Electrical Characteristics (Note 4) Low power V_S = 5V, I_{SET} = 10 μA

| Symbol | Parameter | Conditions | LP365A | | | LP365 | | | Units (Limit) |
|-------------------|---------------------------------|---|--------|-----------------------|-----------------------|-------|-----------------------|-----------------------|---------------|
| | | | Typ | Tested Limit (Note 5) | Design Limit (Note 6) | Typ | Tested Limit (Note 5) | Design Limit (Note 6) | |
| V _{OS} | Input Offset Voltage | V _{CM} = 0V, R _S = 100 | 1 | 3 | 6 | 3 | 6 | 9 | mV (Max) |
| I _{OS} | Input Offset Current | V _{CM} = 0V LP265 | 2 | 20 | 50 | 4 | 25 | 75 | nA (Max) |
| I _B | Input Bias Current | V _{CM} = 0V LP265 | 10 | 50 | 125 | 15 | 75 | 200 | nA (Max) |
| A _{VOL} | Large Signal Voltage Gain | R _L = 100k | 500 | 50 | 50 | 300 | 25 | 25 | V/mV (Min) |
| V _{CM} | Input Common-Mode Voltage Range | | | 0 | 0 | | 0 | 0 | V (Max) |
| | | | | 3 | 3 | | 3 | 3 | V (Min) |
| CMRR | Common-Mode Rejection Ratio | 0 ≤ V _{CM} ≤ 3V | 85 | 75 | 70 | 80 | 75 | 70 | dB (Min) |
| PSRR | Supply Voltage Rejection Ratio | ±2.5V ≤ V _S ≤ ±3.5V | 75 | 65 | 65 | 70 | 65 | 65 | dB (Min) |
| I _S | Supply Current | All Inputs = 0V, R _L = ∞ | 215 | 250 | 300 | 225 | 275 | 300 | μA (Max) |
| V _{OH} | Output Voltage High | V _C = 5V, V _E = 0V, R _L = 100k | | 4.9 | 4.5 | | 4.9 | 4.5 | V (Min) |
| V _{OL} | Output Voltage Low | V _E = 0V | | 0.4 | 0.4 | | 0.4 | 0.4 | V (Max) |
| I _{SINK} | Output Sink Current | V _E = 0V, V _O = 0.4V | 2.4 | 1.2 | 0.6 | 2.0 | 0.8 | 0.4 | mA (Min) |
| I _{LEAK} | Output Leakage Current | V _C = 5V, V _E = 0V | 2 | 50 | 5000 | 2 | 100 | 5000 | nA (Max) |
| t _R | Response Time | V _{CC} = 5V, V _E = 0V, R _L = 5k, C _L = 10 pF (Note 7) | 4 | | | 4 | | | μs |

Electrical Characteristics (Continued) (Note 8) High power $V_S = \pm 15V$, $I_{SET} = 100 \mu A$

| Symbol | Parameter | Conditions | LP365A | | | LP365 | | | Units (Limit) |
|------------|---------------------------------|---|--------|-----------------------|-----------------------|-------|-----------------------|-----------------------|---------------|
| | | | Typ | Tested Limit (Note 5) | Design Limit (Note 6) | Typ | Tested Limit (Note 5) | Design Limit (Note 6) | |
| V_{OS} | Input Offset Voltage | $V_{CM} = 0V$, $R_S = 100$ | 1 | 3 | 6 | 3 | 6 | 9 | mV (Max) |
| I_{OS} | Input Offset Current | $V_{CM} = 0V$ LP265 | 5 | 50 | 100 | 10 | 90 | 200 | nA (Max) |
| | | | | | | 10 | 90 | 500 | |
| I_B | Input Bias Current | $V_{CM} = 0V$ LP265 | 60 | 200 | 500 | 80 | 300 | 500 | nA (Max) |
| | | | | | | 80 | 300 | 800 | |
| A_{VOL} | Large Signal Voltage Gain | $R_L = 15k$ | 500 | 100 | 100 | 500 | 100 | 100 | V/mV (Min) |
| V_{CM} | Input Common-Mode Voltage Range | | | -15 | -15 | | -15 | -15 | V (Max) |
| | | | | 13 | 13 | | 13 | 13 | V (Min) |
| CMRR | Common-Mode Rejection Ratio | $-15V \leq V_{CM} \leq 13V$ | 85 | 75 | 70 | 80 | 75 | 70 | dB (Min) |
| PSRR | Supply Voltage Rejection Ratio | $\pm 10V \leq V_S \leq \pm 15V$ | 80 | 70 | 70 | 75 | 70 | 70 | dB (Min) |
| I_S | Supply Current | All Inputs = 0V, $R_L = \infty$, LP265 | 2.6 | 3 | 3.3 | 2.8 | 3.5 | 3.7 | mA (Max) |
| | | | | | | 2.8 | 3.5 | 4.3 | |
| V_{OH} | Output Voltage High | $V_C = 5V$, $V_E = 0V$, $R_L = 100k$ | | 4.9 | 4.5 | | 4.9 | 4.5 | V (Min) |
| V_{OL} | Output Voltage Low | $V_E = 0V$ | | 0.4 | 0.4 | | 0.4 | 0.4 | V (Max) |
| I_{SINK} | Output Sink Current | $V_E = 0V$, $V_O = 0.4V$ | 10 | 8 | 5.5 | 7.5 | 6 | 4 | mA (Min) |
| I_{LEAK} | Output Leakage Current | $V_C = 15V$, $V_E = -15V$ | 5 | 50 | 5000 | 5 | 50 | 5000 | nA (Max) |
| t_R | Response Time | $V_{CC} = 5V$, $V_E = 0V$, $R_L = 5k$, $C_L = 10 \mu F$ (Note 7) | 1.0 | | | 1.0 | | | μs |

Note 1: The input voltage is not allowed to go 0.3V above V^+ or -0.3V below V^- as this will turn on a parasitic transistor causing large currents to flow through the device.

Note 2: Short circuits from the output to V^+ may cause excessive heating and eventual destruction. The current in the output leads and the V_E lead should not be allowed to exceed 30 mA. The output should not be shorted to V^- if $V_E \leq (V^-) + 7V$.

Note 3: For operating at elevated temperatures, these devices must be derated based on a thermal resistance of θ_{JA} and T_J max. $T_J = T_A + \theta_{JA} P_D$.

Note 4: Boldface numbers apply at temperature extremes. All other numbers apply at $T_A = T_J = 25^\circ C$. $V^+ = 5V$, $V^- = 0V$, $I_{SET} = 10 \mu A$, $R_L = 100k$, and $V_C = 5V$ as shown in the Typical Connection diagram.

Note 5: Guaranteed and 100% production tested.

Note 6: Guaranteed (but not 100% production tested) over the operating temperature and supply voltage ranges. These limits are not used to calculate out-going quality levels.

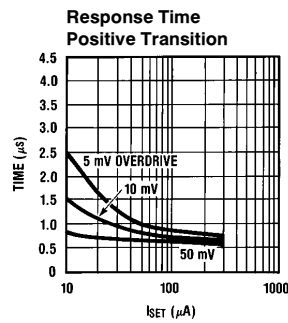
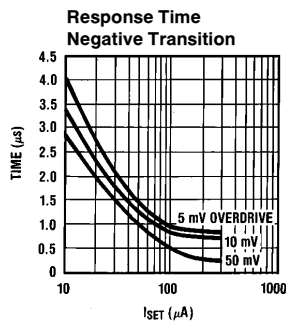
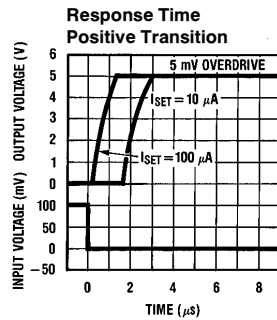
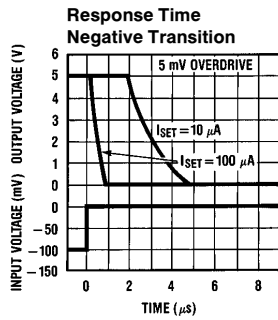
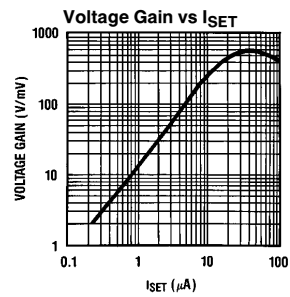
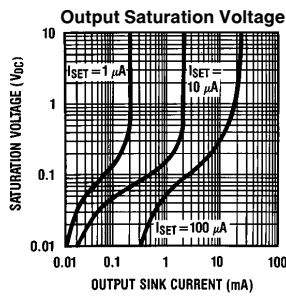
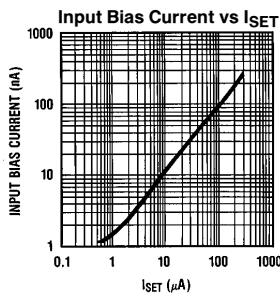
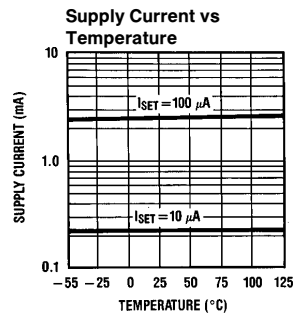
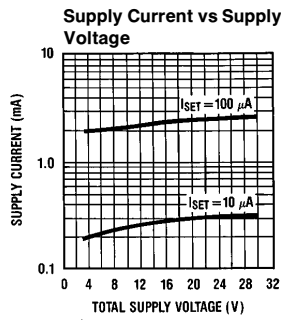
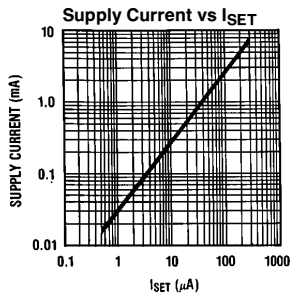
Note 7: The response time specified is for a 100 mV input step with 5 mV overdrive.

Note 8: Boldface numbers apply at temperature extremes. All other numbers apply at $T_A = T_J = 25^\circ C$. $V^+ = +15V$, $V^- = -15V$, $I_{SET} = 100 \mu A$, $R_L = 100k$, and $V_C = 5V$ as shown in the Typical Connection diagram.

Note 9: See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

Note 10: Human body model, 1.5 k Ω in series with 100 pF.

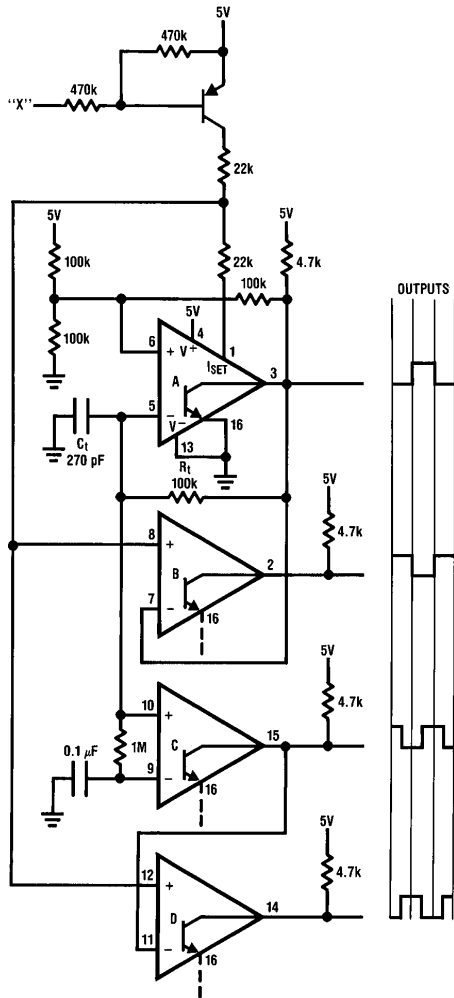
Typical Performance Characteristics



TL/H/5023-3

Typical Applications

Gated 4-Phase Oscillator



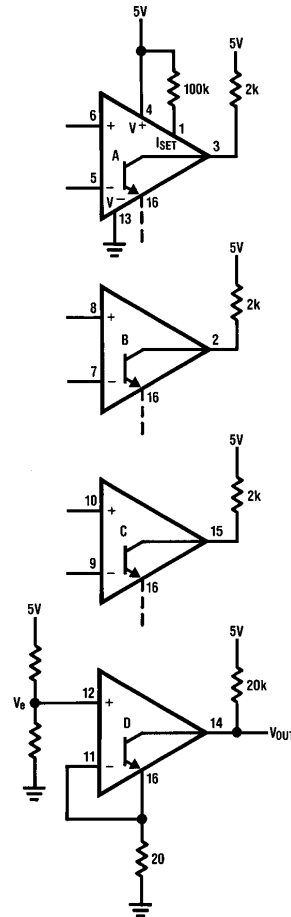
TL/H/5023-4

$$f = 20 \text{ kHz}$$

$$f = \frac{1}{1.6 \cdot R_1 \cdot C_1}$$

All four phases run when X is low. When X is high, oscillation stops and power drain is zero.

“Voting” Comparator

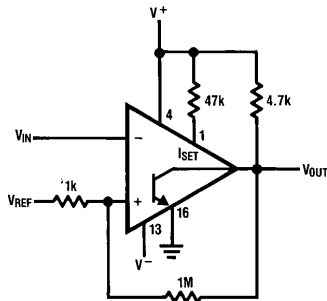


TL/H/5023-5

If $V_E = 0.25V$, then V_{OUT} will be low if 1 of the 3 other outputs are low. Choice of $V_E = 0.50V$ causes V_{OUT} to be low if 2 of the 3 other outputs are low; $V_E = 0.75V$ will cause V_{OUT} to be low if all 3 other outputs are low.

Typical Applications (Continued)

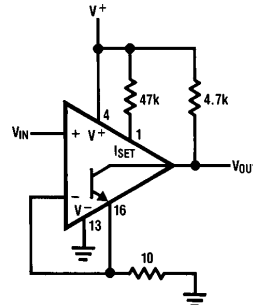
Ordinary Hysteresis



TL/H/5023-6

It is a good practice to add a few millivolts of positive feedback to prevent oscillation when the input voltage is near the threshold.

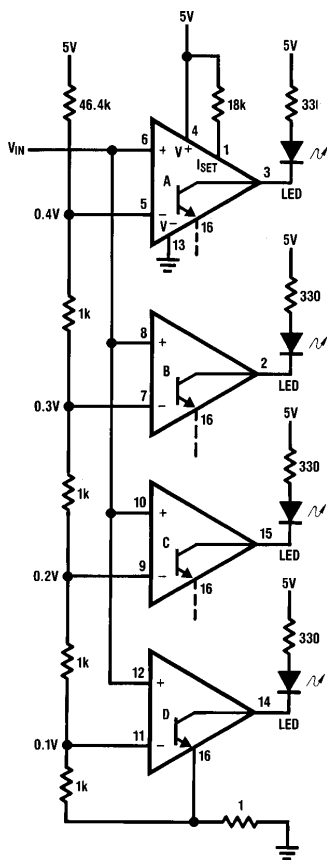
Hysteresis from Emitter



TL/H/5023-7

Positive feedback from the emitter can also prevent oscillations when V_{IN} is near the threshold.

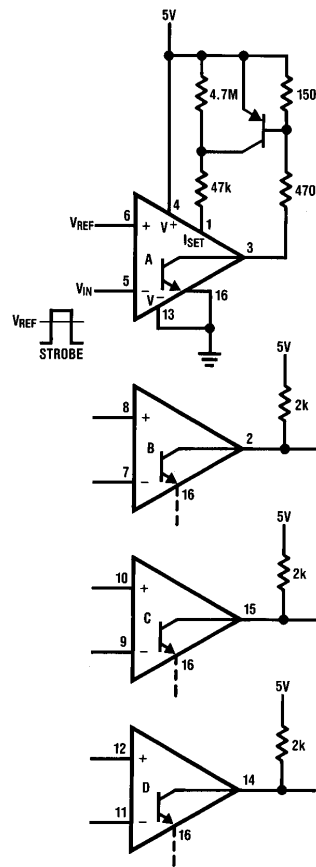
Bar-Graph Display



TL/H/5023-8

The positive feedback from pin 16 provides hysteresis.

Level-Sensitive Strobe

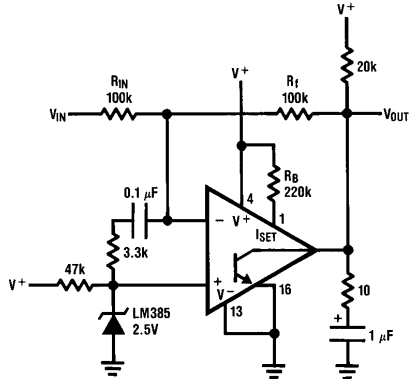


TL/H/5023-9

Comparators B, C, and D do not respond until activated by the signal applied to comparator A.

Typical Applications (Continued)

Slow Op Amp (Inverter)

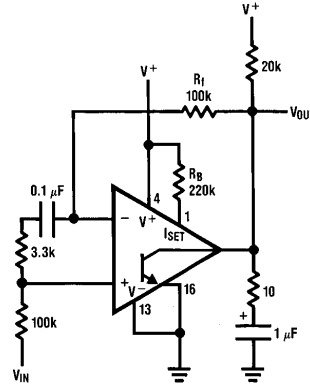


TL/H/5023-10

$$R_B = V^+ / 20 \mu A$$

Unlike most comparators, the LP365 can be used as an op amp, if suitable R-C damping networks are used.

Slow Op Amp (Unity-Gain Follower)

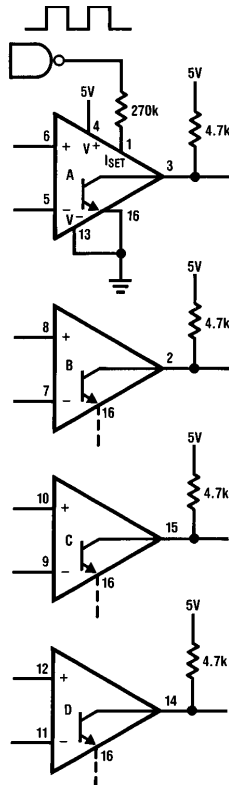


TL/H/5023-11

$$R_B = V^+ / 20 \mu A$$

The LP365 can also be used as a high-input-impedance follower-amplifier with the damping components shown.

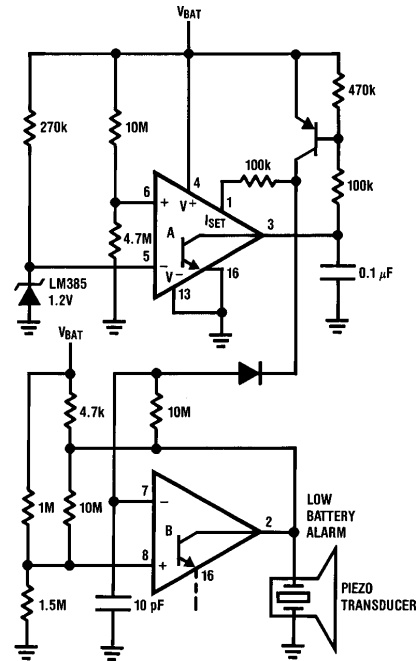
Chopping Outputs



TL/H/5023-12

Chopping the outputs by modulating the I_{SET} current allows data to be transmitted via opto-couplers, transformers, etc.

Low Battery Detector



TL/H/5023-13

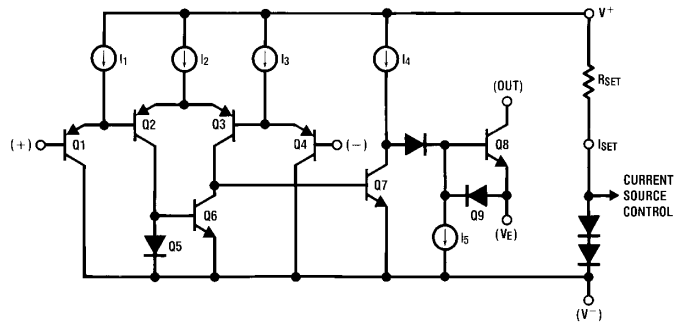
$$I_S @ 6V = 45 \mu A$$

$$I_S @ 3.8V = 1 \mu A$$

$$f = 3 \text{ kHz}$$

Comparator A detects when the supply voltage drops to 4V and enables comparator B to drive a piezoelectric alarm.

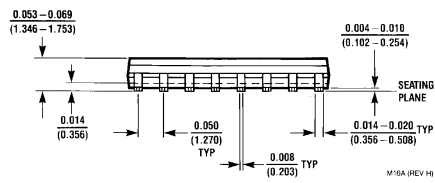
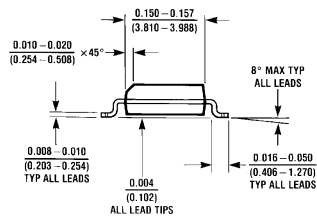
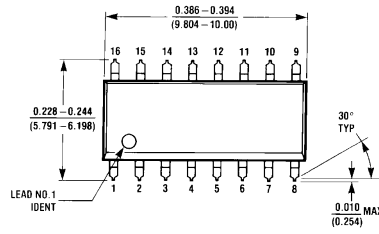
Simplified Schematic



Current sources are programmed by I_{SET}
 V_E is common to all 4 comparators

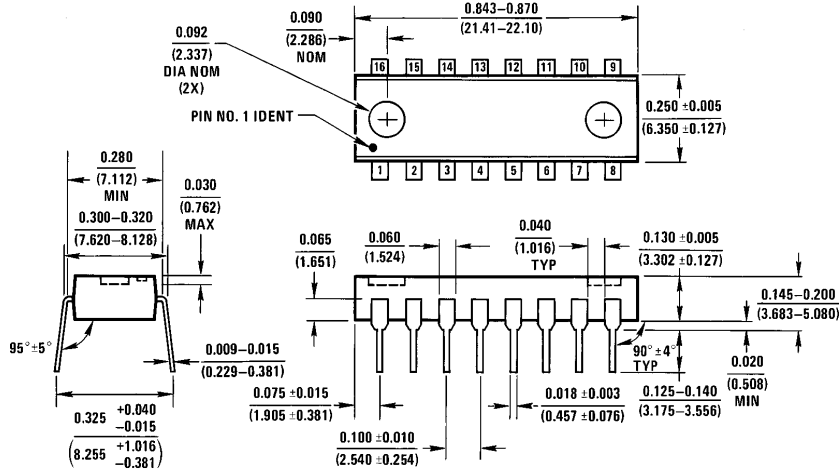
TL/H/5023-14

Physical Dimensions inches (millimeters)



Plastic Surface-Mount Package (M)
Order Number LP365M
NS Package Number M16A

Physical Dimensions inches (millimeters) (Continued)



N16A (REV E)

Molded Dual-In-Line Package (N)
Order Number LP365AN or LP365N
NS Package Number N16A

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National Semiconductor Corporation
 1111 West Bardin Road
 Arlington, TX 76017
 Tel: 1(800) 272-9959
 Fax: 1(800) 737-7018

National Semiconductor Europe
 Fax: (+49) 0-180-530 85 86
 Email: cnjwge@tevm2.nsc.com
 Deutsch Tel: (+49) 0-180-530 85 85
 English Tel: (+49) 0-180-532 78 32
 Français Tel: (+49) 0-180-532 93 58
 Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
 13th Floor, Straight Block,
 Ocean Centre, 5 Canton Rd.
 Tsimshatsui, Kowloon
 Hong Kong
 Tel: (852) 2737-1600
 Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
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