

# NCP4421, NCP4422

## 9.0 A High-Speed MOSFET Drivers

The NCP4421/4422 are high current buffer/drivers capable of driving large MOSFETs and IGBTs.

They are essentially immune to any form of upset except direct overvoltage or over-dissipation – they cannot be latched under any conditions within their power and voltage ratings; they are not subject to damage or improper operation when up to 5.0 V of ground bounce is present on their ground terminals; they can accept, without either damage or logic upset, more than 1.0 A inductive current of either polarity being forced back into their outputs. In addition, all terminals are fully protected against up to 4.0 kV of electrostatic discharge.

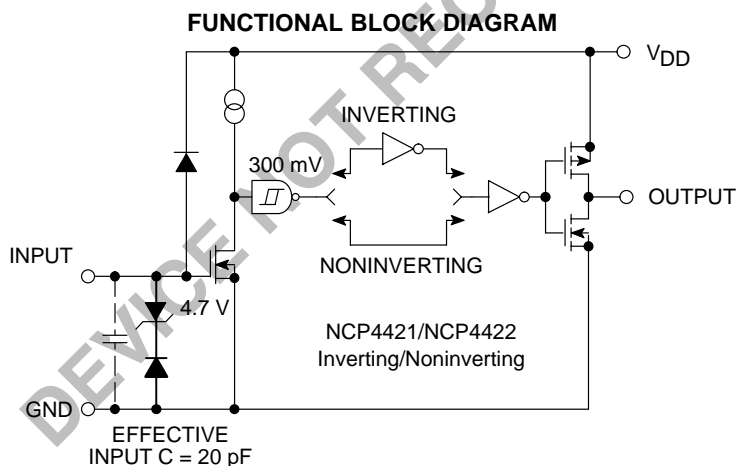
The inputs may be driven directly from either TTL or CMOS (3.0 V to 18 V). In addition, 300 mV of hysteresis is built into the input, providing noise immunity and allowing the device to be driven from slowly rising or falling waveforms.

### Features

- Tough CMOS™ Construction
- High Peak Output Current (9.0 A)
- High Continuous Output Current (2.0 A Max)
- Fast Rise and Fall Times:
  - 30 ns with 4,700 pF Load
  - 180 ns with 47,000 pF Load
- Short Internal Delays (30 nsec Typ)
- Low Output Impedance (1.4  $\Omega$  Typ)

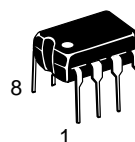
### Applications

- Line Drivers for Extra-Heavily-Loaded Lines
- Pulse Generators
- Driving the Largest MOSFETs and IGBTs
- Local Power ON/OFF Switch
- Motor and Solenoid Driver



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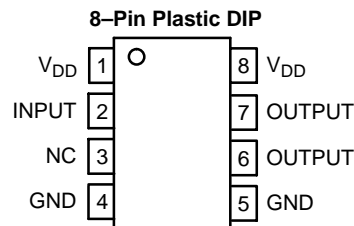


PDIP-8  
P SUFFIX  
CASE 626

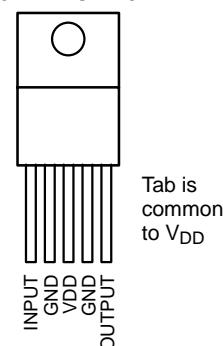


TO-220  
T SUFFIX  
CASE 314D

### PIN CONNECTIONS



### 5-Pin TO-220



NOTE: Duplicate pins must *both* be connected for proper operation.  
NC = No connection

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 8 of this data sheet.

### DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 8 of this data sheet.

# NCP4421, NCP4422

## ABSOLUTE MAXIMUM RATINGS\*

| Rating   | Symbol    | Value                          | Unit  |
|--|-----------|--------------------------------|-------|
| Power Dissipation ( $T_A \leq 70^\circ\text{C}$ )<br>PDIP<br>5-Pin TO-220          | –         | 730<br>1.6                     | W     |
| Power Dissipation ( $T_C \leq 25^\circ\text{C}$ )<br>5-Pin TO-220 (With Heat Sink) | –         | 12.5                           | W     |
| Derating Factors (To Ambient)<br>PDIP<br>5-Pin TO-220                              | –         | 8.0<br>12                      | mW/°C |
| Thermal Impedance (To Case)<br>5-Pin TO-220 $R_{\theta JC}$                        | –         | 10                             | °C/W  |
| Storage Temperature  | $T_{stg}$ | –65 to +150                    | °C    |
| Operating Temperature (Chip)   | –         | 150                            | °C    |
| Operating Temperature (Ambient)<br>TO-220 Version<br>PDIP Version                  | –         | 0 to +70<br>–40 to +85         | °C    |
| Lead Temperature (10 Seconds)  | –         | 300                            | °C    |
| Supply Voltage   | $V_{CC}$  | 20                             | V     |
| Input Voltage  | –         | $V_{DD} + 3.0$ to<br>GND – 5.0 | V     |
| Input Current ( $V_{IN} > V_{DD}$ )  | –         | 50                             | mA    |

\*Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ with $4.5\text{ V} \leq V_{DD} \leq 18\text{ V}$ unless otherwise specified.)

| Characteristics                | Test Conditions   | Symbol    | Min   | Typ | Max   | Unit          |
|--------------------------------|---|-----------|---|-----|-------|---------------|
| <b>Input</b>                   |   |           |   |     |       |               |
| Logic 1 Input Voltage          | –   | $V_{IH}$  | 2.4   | 1.8 | –     | V             |
| Logic 0 Input Voltage          | –   | $V_{IL}$  | –   | 1.3 | 0.8   | V             |
| Input Current                  | $0\text{ V} \leq V_{IN} \leq V_{DD}$  | $I_{IN}$  | –10   | –   | 10    | $\mu\text{A}$ |
| <b>Output</b>                  |   |           |   |     |       |               |
| High Output Voltage            | See Figure 1  | $V_{OH}$  | $V_{DD} - 0.025$                            | –   | –     | V             |
| Low Output Voltage             | See Figure 1  | $V_{OL}$  | –   | –   | 0.025 | V             |
| Output Resistance, High        | $V_{DD} = 18\text{ V}$ , $I_O = 10\text{ mA}$   | $R_O$     | –   | 1.4 | –     | $\Omega$      |
| Output Resistance, Low         | $V_{DD} = 18\text{ V}$ , $I_O = 10\text{ mA}$   | $R_O$     | –   | 0.9 | 1.7   | $\Omega$      |
| Peak Output Current            | $V_{DD} = 18\text{ V}$  | $I_{PK}$  | –   | 9.0 | –     | A             |
| Continuous Output Current      | $10\text{ V} \leq V_{DD} \leq 18\text{ V}$ , $T_C = 25^\circ$<br>(TC4421/22 CAT only) | $I_{DC}$  | 2.0   | –   | –     | A             |
| Latch-Up Protection            | Duty Cycle $\leq 2\%$<br>Withstand Reverse Current                                    | $I_{REV}$ | $> 1500$<br>$t \leq 300\text{ }\mu\text{s}$ | –   | –     | mA            |
| <b>Switching Time</b> (Note 1) |   |           |   |     |       |               |
| Rise Time                      | Figure 1, $C_L = 10,000\text{ pF}$  | $t_R$     | –   | 60  | 75    | nsec          |
| Fall Time                      | Figure 1, $C_L = 10,000\text{ pF}$  | $t_F$     | –   | 60  | 75    | nsec          |
| Delay Time                     | Figure 1  | $t_{D1}$  | –   | 30  | 60    | nsec          |
| Delay Time                     | Figure 1  | $t_{D2}$  | –   | 33  | 60    | nsec          |

1. Switching times guaranteed by design.

# NCP4421, NCP4422

## ELECTRICAL CHARACTERISTICS (continued) ( $T_A = 25^\circ\text{C}$ with $4.5\text{ V} \leq V_{DD} \leq 18\text{ V}$ unless otherwise specified.)

| Characteristics | Test Conditions | Symbol | Min | Typ | Max | Unit |
|-----------------|-----------------|--------|-----|-----|-----|------|
|-----------------|-----------------|--------|-----|-----|-----|------|

### Power Supply

|                         |  |          |        |           |            |                     |
|-------------------------|--|----------|--------|-----------|------------|---------------------|
| Power Supply Current    | $V_{IN} = 3.0\text{ V}$<br>$V_{IN} = 0\text{ V}$ | $I_S$    | –<br>– | 0.2<br>55 | 1.5<br>150 | mA<br>$\mu\text{A}$ |
| Operating Input Voltage | –  | $V_{DD}$ | 4.5    | –         | 18         | V                   |

### Input

|                       |                                      |          |     |   |     |               |
|-----------------------|--------------------------------------|----------|-----|---|-----|---------------|
| Logic 1 Input Voltage | –                                    | $V_{IH}$ | 2.4 | – | –   | V             |
| Logic 0 Input Voltage | –                                    | $V_{IL}$ | –   | – | 0.8 | V             |
| Input Current         | $0\text{ V} \leq V_{IN} \leq V_{DD}$ | $I_{IN}$ | –10 | – | 10  | $\mu\text{A}$ |

## ELECTRICAL CHARACTERISTICS (Measured over operating temperature range with $4.5\text{ V} \leq V_S \leq 18\text{ V}$ unless otherwise specified.)

| Characteristics | Test Conditions | Symbol | Min | Typ | Max | Unit |
|-----------------|-----------------|--------|-----|-----|-----|------|
|-----------------|-----------------|--------|-----|-----|-----|------|

### Input

|                       |                                      |          |     |   |     |               |
|-----------------------|--------------------------------------|----------|-----|---|-----|---------------|
| Logic 1 Input Voltage | –                                    | $V_{IH}$ | 2.4 | – | –   | V             |
| Logic 0 Input Voltage | –                                    | $V_{IL}$ | –   | – | 0.8 | V             |
| Input Current         | $0\text{ V} \leq V_{IN} \leq V_{DD}$ | $I_{IN}$ | –10 | – | 10  | $\mu\text{A}$ |

### Output

|                         |   |          |                  |     |       |          |
|-------------------------|---|----------|------------------|-----|-------|----------|
| High Output Voltage     | See Figure 1                                  | $V_{OH}$ | $V_{DD} - 0.025$ | –   | –     | V        |
| Low Output Voltage      | See Figure 1                                  | $V_{OL}$ | –                | –   | 0.025 | V        |
| Output Resistance, High | $V_{DD} = 18\text{ V}$ , $I_O = 10\text{ mA}$ | $R_O$    | –                | 2.4 | 3.6   | $\Omega$ |
| Output Resistance, Low  | $V_{DD} = 18\text{ V}$ , $I_O = 10\text{ mA}$ | $R_O$    | –                | 1.8 | 2.7   | $\Omega$ |

### Switching Time (Note 1)

|            |                                    |          |   |    |     |      |
|------------|------------------------------------|----------|---|----|-----|------|
| Rise Time  | Figure 1, $C_L = 10,000\text{ pF}$ | $t_R$    | – | 60 | 120 | nsec |
| Fall Time  | Figure 1, $C_L = 10,000\text{ pF}$ | $t_F$    | – | 60 | 120 | nsec |
| Delay Time | Figure 1                           | $t_{D1}$ | – | 50 | 80  | nsec |
| Delay Time | Figure 1                           | $t_{D2}$ | – | 65 | 80  | nsec |

### Power Supply

|                         |  |          |        |              |            |    |
|-------------------------|--|----------|--------|--------------|------------|----|
| Power Supply Current    | $V_{IN} = 3.0\text{ V}$<br>$V_{IN} = 0\text{ V}$ | $I_S$    | –<br>– | 0.45<br>0.06 | 3.0<br>0.2 | mA |
| Operating Input Voltage | –  | $V_{DD}$ | 4.5    | –            | 18         | V  |

1. Switching times guaranteed by design.

# NCP4421, NCP4422

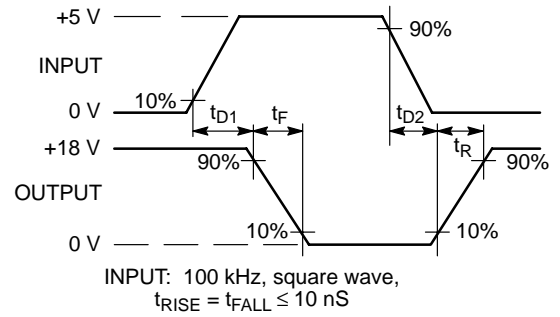
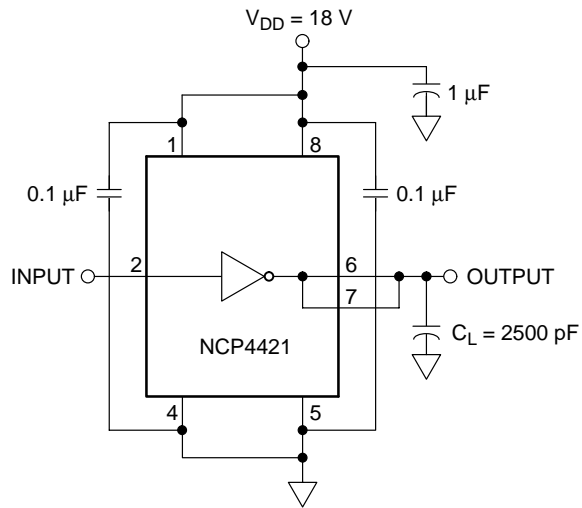


Figure 1. Switching Time Test Circuit

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 DEVICE NOT RECOMMENDED FOR NEW DESIGN

TYPICAL ELECTRICAL CHARACTERISTICS

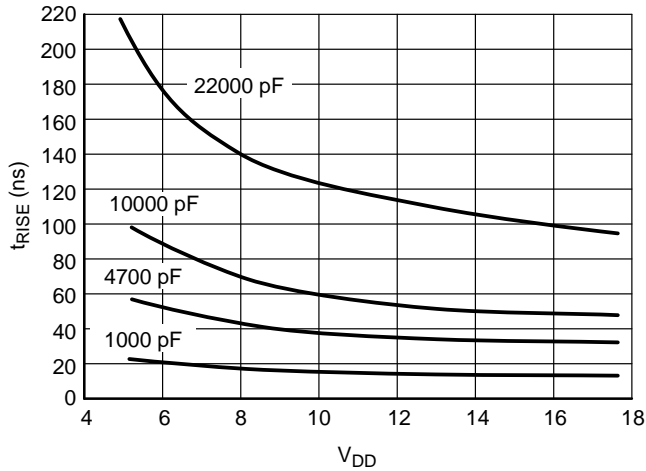


Figure 2. Rise Time vs. Supply Voltage

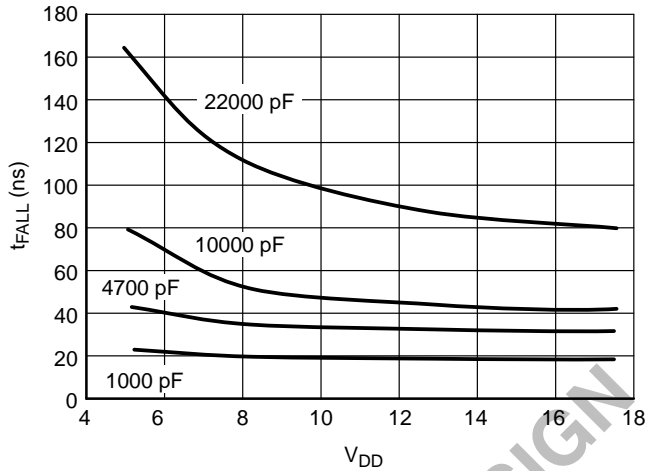


Figure 3. Fall Time vs. Supply Voltage

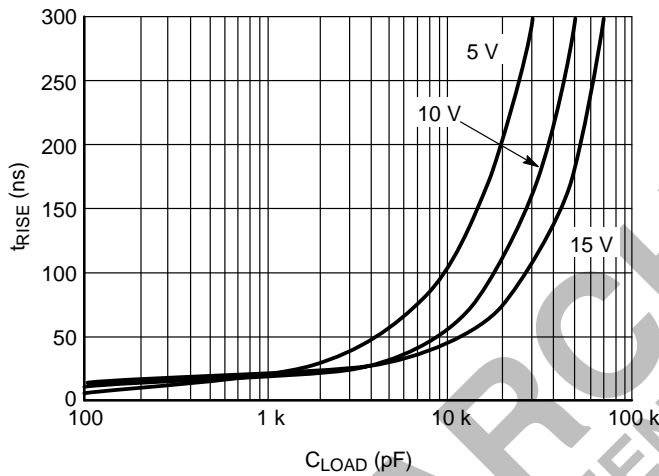


Figure 4. Rise Time vs. Capacitive Load

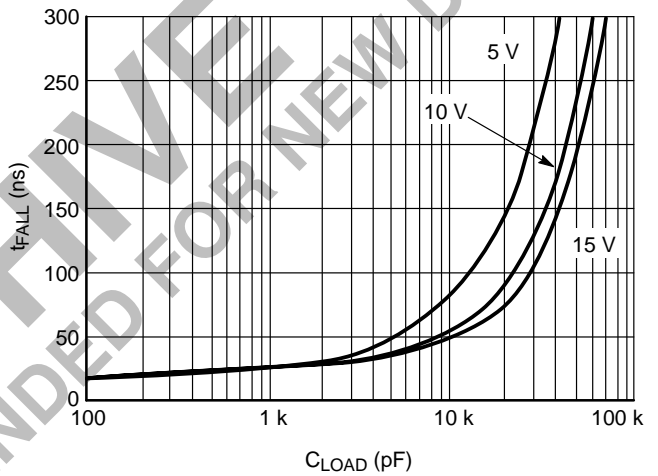


Figure 5. Fall Time vs. Capacitive Load

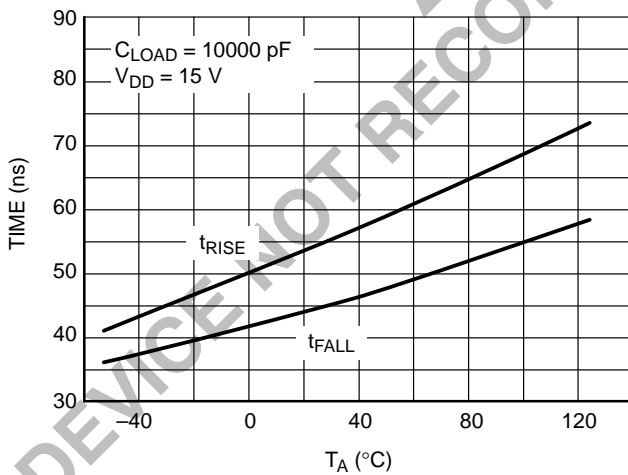


Figure 6. Rise and Fall Times vs. Temperature

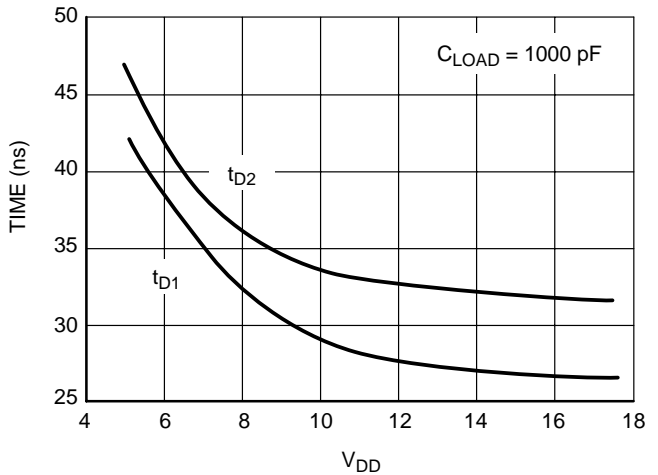


Figure 7. Propagation Delay vs. Supply Voltage

TYPICAL ELECTRICAL CHARACTERISTICS

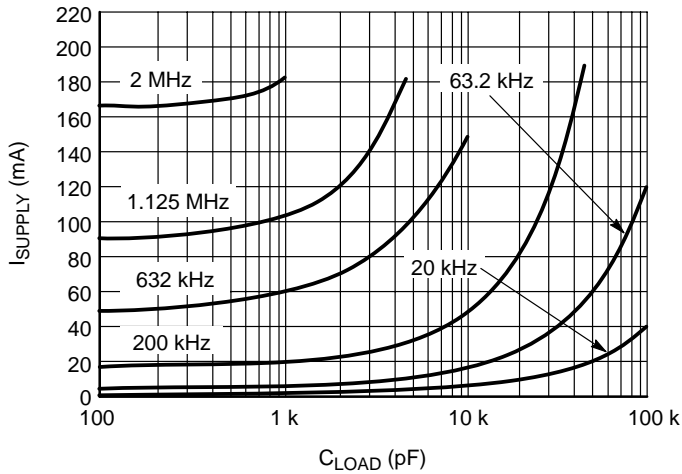


Figure 8. Supply Current vs. Capacitive Load ( $V_{DD} = 18\text{ V}$ )

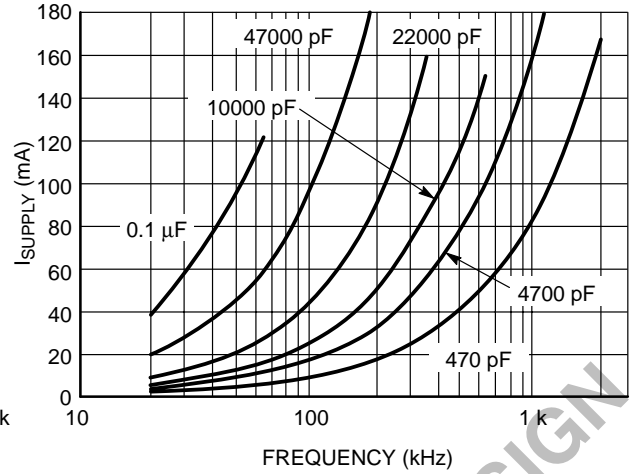


Figure 9. Supply Current vs. Frequency ( $V_{DD} = 18\text{ V}$ )

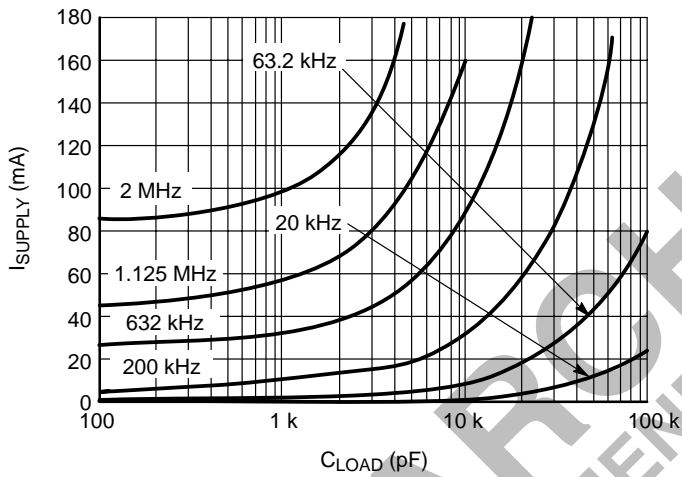


Figure 10. Supply Current vs. Capacitive Load ( $V_{DD} = 12\text{ V}$ )

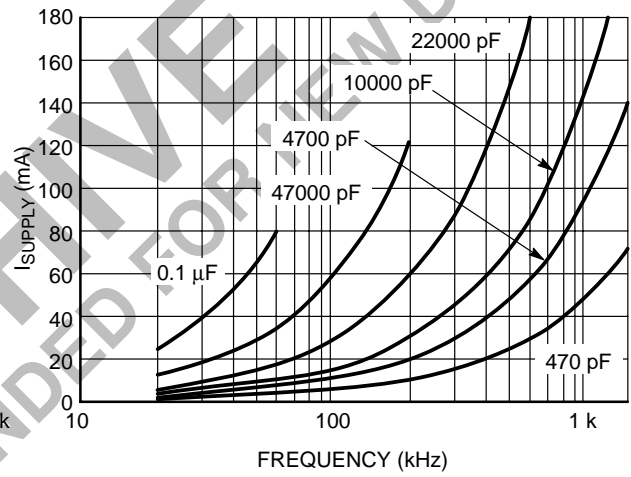


Figure 11. Supply Current vs. Frequency ( $V_{DD} = 12\text{ V}$ )

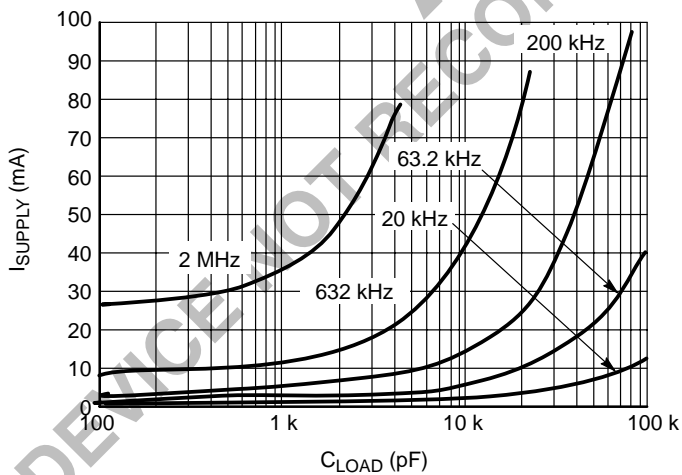


Figure 12. Supply Current vs. Capacitive Load ( $V_{DD} = 6\text{ V}$ )

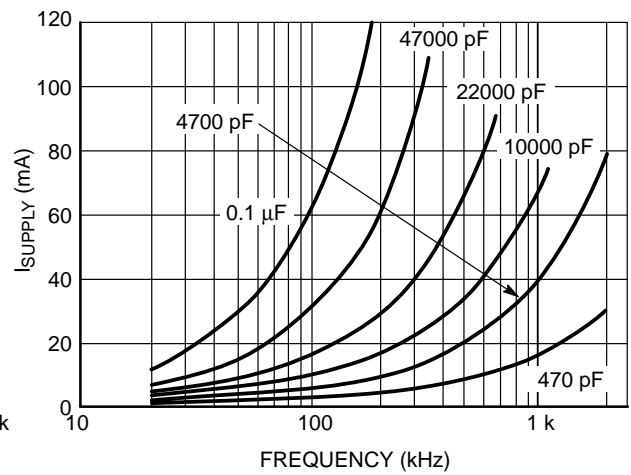


Figure 13. Supply Current vs. Frequency ( $V_{DD} = 6\text{ V}$ )

TYPICAL ELECTRICAL CHARACTERISTICS

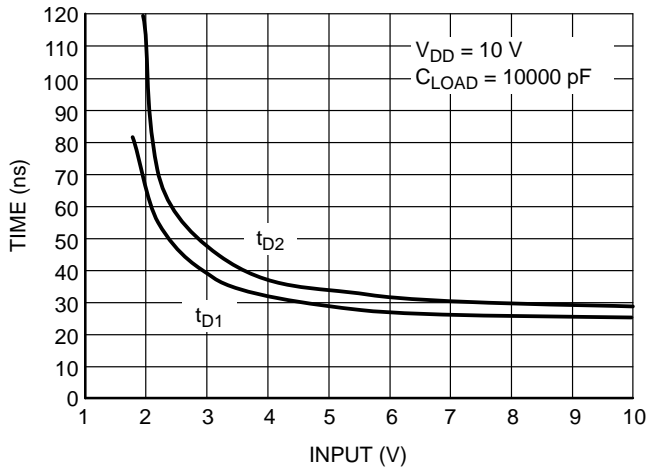


Figure 14. Propagation Delay vs. Input Amplitude

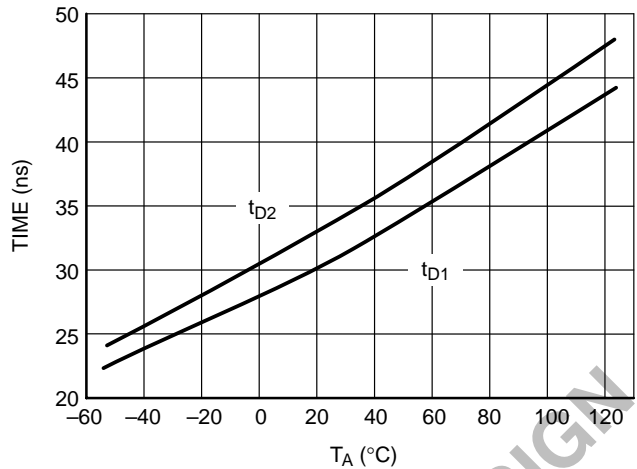


Figure 15. Propagation Delay vs. Temperature

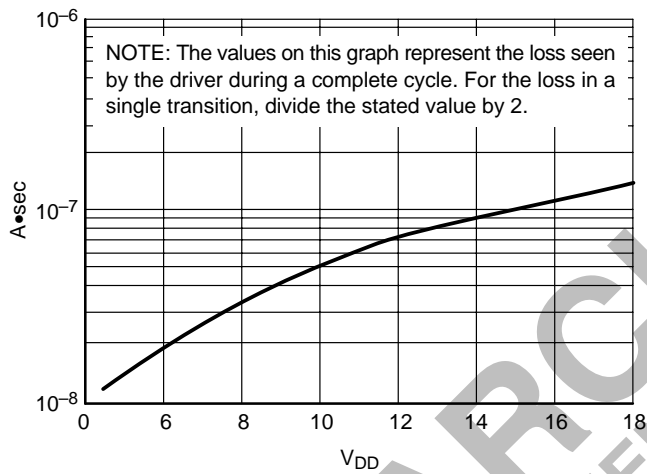


Figure 16. Crossover Energy vs. Supply Voltage

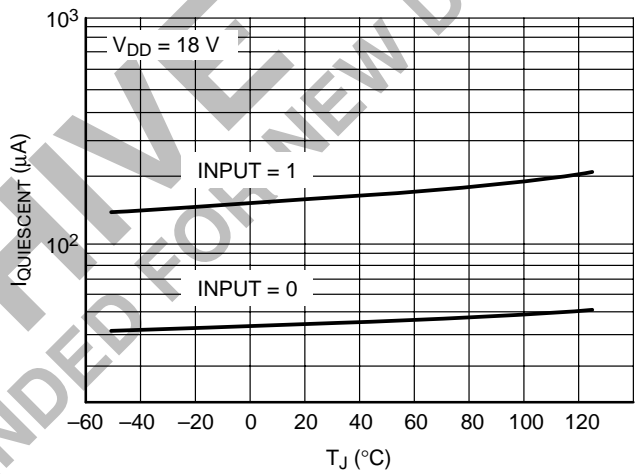


Figure 17. Quiescent Supply Current vs. Temperature

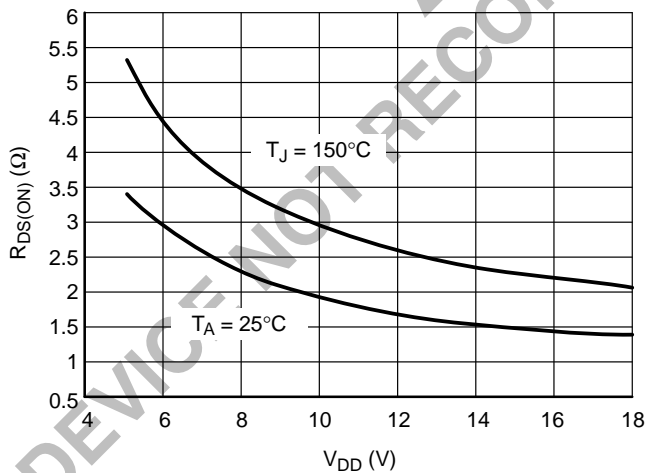


Figure 18. High-State Output Resistance vs. Supply Voltage

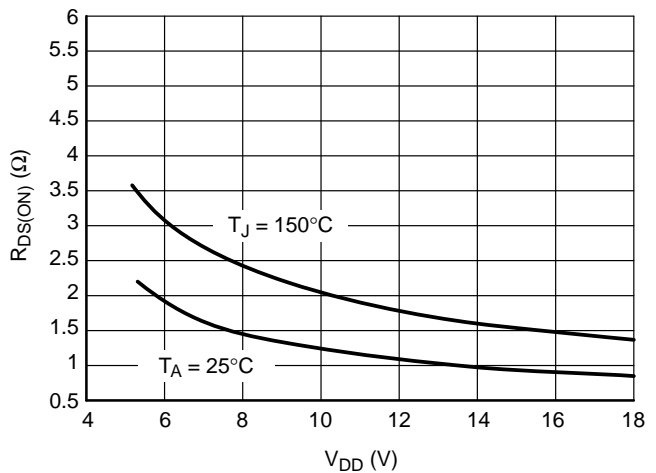
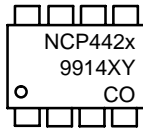


Figure 19. Low-State Output Resistance vs. Supply Voltage

## NCP4421, NCP4422

### MARKING DIAGRAMS



x = 1 or 2  
X = Assembly ID Code  
Y = Year  
CO = Country of Origin

### ORDERING INFORMATION

| Device   | Package      | Temperature Range | Shipping      |
|----------|--------------|-------------------|---------------|
| NCP4421T | 5-Pin TO-220 | 0°C to + 70°C     | 50 Units/Rail |
| NCP4421P | 8-Pin PDIP   | -40°C to + 85°C   | 50 Units/Rail |
| NCP4422T | 5-Pin TO-220 | 0°C to + 70°C     | 50 Units/Rail |
| NCP4422P | 8-Pin PDIP   | -40°C to + 85°C   | 50 Units/Rail |



## Notes

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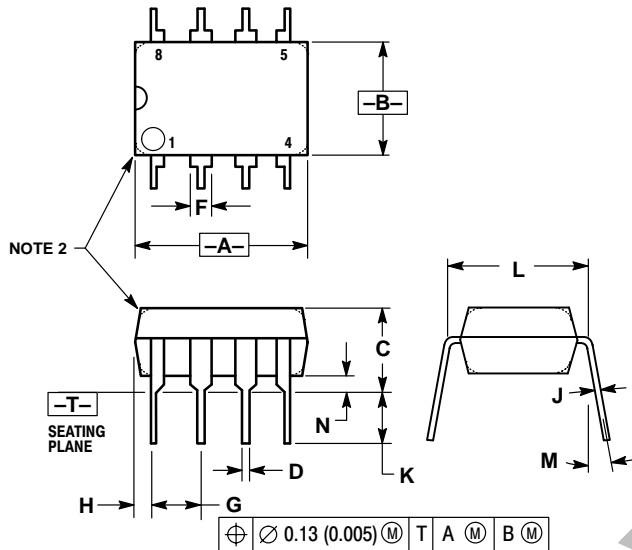
## Notes

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# NCP4421, NCP4422

## PACKAGE DIMENSIONS

PDIP  
P SUFFIX  
CASE 626-05  
ISSUE K

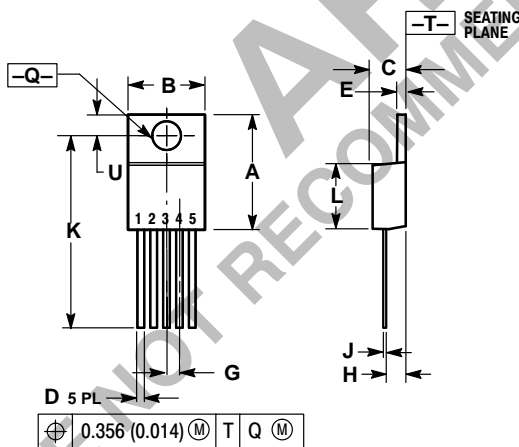


### NOTES:

1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | 9.40        | 10.16 | 0.370     | 0.400 |
| B   | 6.10        | 6.60  | 0.240     | 0.260 |
| C   | 3.94        | 4.45  | 0.155     | 0.175 |
| D   | 0.38        | 0.51  | 0.015     | 0.020 |
| F   | 1.02        | 1.78  | 0.040     | 0.070 |
| G   | 2.54 BSC    |       | 0.100 BSC |       |
| H   | 0.76        | 1.27  | 0.030     | 0.050 |
| J   | 0.20        | 0.30  | 0.008     | 0.012 |
| K   | 2.92        | 3.43  | 0.115     | 0.135 |
| L   | 7.62 BSC    |       | 0.300 BSC |       |
| M   | 10°         |       | 10°       |       |
| N   | 0.76        | 1.01  | 0.030     | 0.040 |

TO-220  
T SUFFIX  
CASE 314D-04  
ISSUE E




### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION D DOES NOT INCLUDE INTERCONNECT BAR (DAMBAR) PROTRUSION. DIMENSION D INCLUDING PROTRUSION SHALL NOT EXCEED 10.92 (0.043) MAXIMUM.

| DIM | INCHES    |       | MILLIMETERS |        |
|-----|-----------|-------|-------------|--------|
|     | MIN       | MAX   | MIN         | MAX    |
| A   | 0.572     | 0.613 | 14.529      | 15.570 |
| B   | 0.390     | 0.415 | 9.906       | 10.541 |
| C   | 0.170     | 0.180 | 4.318       | 4.572  |
| D   | 0.025     | 0.038 | 0.635       | 0.965  |
| E   | 0.048     | 0.055 | 1.219       | 1.397  |
| G   | 0.067 BSC |       | 1.702 BSC   |        |
| H   | 0.087     | 0.112 | 2.210       | 2.845  |
| J   | 0.015     | 0.025 | 0.381       | 0.635  |
| K   | 0.990     | 1.045 | 25.146      | 26.543 |
| L   | 0.320     | 0.365 | 8.128       | 9.271  |
| Q   | 0.140     | 0.153 | 3.556       | 3.886  |
| U   | 0.105     | 0.117 | 2.667       | 2.972  |

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RECOMMENDED FOR NEW DESIGN

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