



**MOTOROLA**

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## MC1413, B MC1416, B

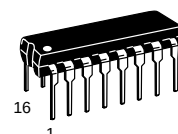
# High Voltage, High Current Darlington Transistor Arrays

The seven NPN Darlington connected transistors in these arrays are well suited for driving lamps, relays, or printer hammers in a variety of industrial and consumer applications. Their high breakdown voltage and internal suppression diodes insure freedom from problems associated with inductive loads. Peak inrush currents to 500 mA permit them to drive incandescent lamps.

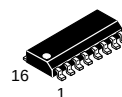
The MC1413, B with a 2.7 k $\Omega$  series input resistor is well suited for systems utilizing a 5.0 V TTL or CMOS Logic. The MC1416, B uses a series 10.5 k $\Omega$  resistor and is useful in 8.0 to 18 V MOS systems.

### ORDERING INFORMATION

| Plastic DIP                              | SOIC                 | Operating Temperature Range                      |
|------------------------------------------|----------------------|--------------------------------------------------|
| MC1413P (ULN2003A)<br>MC1416P (ULN2004A) | MC1413D<br>MC1416D   | $T_A = -20^\circ \text{ to } +85^\circ \text{C}$ |
| MC1413BP<br>MC1416BP                     | MC1413BD<br>MC1416BD | $T_A = -40^\circ \text{ to } +85^\circ \text{C}$ |

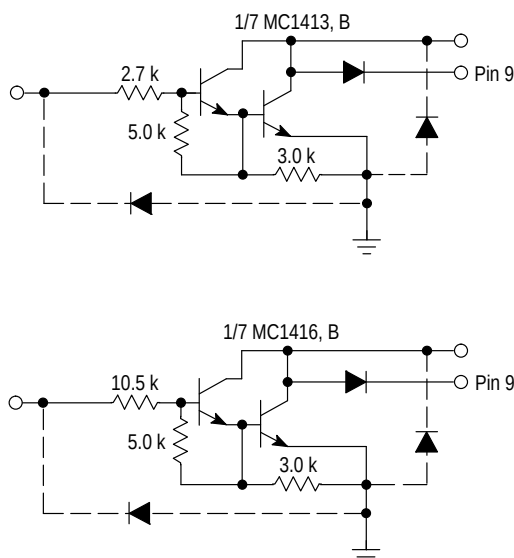


**P SUFFIX**  
PLASTIC PACKAGE  
CASE 648

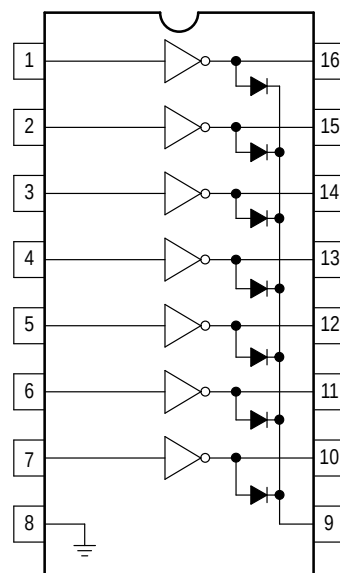


**D SUFFIX**  
PLASTIC PACKAGE  
CASE 751B  
(SO-16)

### Representative Schematic Diagrams



### PIN CONNECTIONS



(Top View)

## MC1413, B MC1416, B

**MAXIMUM RATINGS** ( $T_A = 25^\circ\text{C}$ , and rating apply to any one device in the package, unless otherwise noted.)

| Rating                                                                               | Symbol           | Value                    | Unit               |
|--------------------------------------------------------------------------------------|------------------|--------------------------|--------------------|
| Output Voltage                                                                       | $V_O$            | 50                       | V                  |
| Input Voltage                                                                        | $V_I$            | 30                       | V                  |
| Collector Current – Continuous                                                       | $I_C$            | 500                      | mA                 |
| Base Current – Continuous                                                            | $I_B$            | 25                       | mA                 |
| Operating Ambient Temperature Range<br>MC1413–16<br>MC1413B–16B                      | $T_A$            | –20 to +85<br>–40 to +85 | $^\circ\text{C}$   |
| Storage Temperature Range                                                            | $T_{\text{stg}}$ | –55 to +150              | $^\circ\text{C}$   |
| Junction Temperature                                                                 | $T_J$            | 150                      | $^\circ\text{C}$   |
| Thermal Resistance, Junction–to–Ambient<br>Case 648, P Suffix<br>Case 751B, D Suffix | $\theta_{JA}$    | 67<br>100                | $^\circ\text{C/W}$ |

**NOTE:** ESD data available upon request.

### ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)

| Characteristic                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Symbol               | Min                             | Typ                             | Max                                           | Unit          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------------|---------------------------------|-----------------------------------------------|---------------|
| Output Leakage Current<br>( $V_O = 50\text{ V}$ , $T_A = +85^\circ\text{C}$ )<br>( $V_O = 50\text{ V}$ , $T_A = +25^\circ\text{C}$ )<br>( $V_O = 50\text{ V}$ , $T_A = +85^\circ\text{C}$ , $V_I = 1.0\text{ V}$ )                                                                                                                                                                                                                                                             | $I_{\text{CEX}}$     | –<br>–<br>–                     | –<br>–<br>–                     | 100<br>50<br>500                              | $\mu\text{A}$ |
| Collector–Emitter Saturation Voltage<br>( $I_C = 350\text{ mA}$ , $I_B = 500\text{ }\mu\text{A}$ )<br>( $I_C = 200\text{ mA}$ , $I_B = 350\text{ }\mu\text{A}$ )<br>( $I_C = 100\text{ mA}$ , $I_B = 250\text{ }\mu\text{A}$ )                                                                                                                                                                                                                                                 | $V_{\text{CE(sat)}}$ | –<br>–<br>–                     | 1.1<br>0.95<br>0.85             | 1.6<br>1.3<br>1.1                             | V             |
| Input Current – On Condition<br>( $V_I = 3.85\text{ V}$ )<br>( $V_I = 5.0\text{ V}$ )<br>( $V_I = 12\text{ V}$ )                                                                                                                                                                                                                                                                                                                                                               | $I_{\text{I(on)}}$   | –<br>–<br>–                     | 0.93<br>0.35<br>1.0             | 1.35<br>0.5<br>1.45                           | mA            |
| Input Voltage – On Condition<br>( $V_{\text{CE}} = 2.0\text{ V}$ , $I_C = 200\text{ mA}$ )<br>( $V_{\text{CE}} = 2.0\text{ V}$ , $I_C = 250\text{ mA}$ )<br>( $V_{\text{CE}} = 2.0\text{ V}$ , $I_C = 300\text{ mA}$ )<br>( $V_{\text{CE}} = 2.0\text{ V}$ , $I_C = 125\text{ mA}$ )<br>( $V_{\text{CE}} = 2.0\text{ V}$ , $I_C = 200\text{ mA}$ )<br>( $V_{\text{CE}} = 2.0\text{ V}$ , $I_C = 275\text{ mA}$ )<br>( $V_{\text{CE}} = 2.0\text{ V}$ , $I_C = 350\text{ mA}$ ) | $V_{\text{I(on)}}$   | –<br>–<br>–<br>–<br>–<br>–<br>– | –<br>–<br>–<br>–<br>–<br>–<br>– | 2.4<br>2.7<br>3.0<br>5.0<br>6.0<br>7.0<br>8.0 | V             |
| Input Current – Off Condition<br>( $I_C = 500\text{ }\mu\text{A}$ , $T_A = 85^\circ\text{C}$ )                                                                                                                                                                                                                                                                                                                                                                                 | $I_{\text{I(off)}}$  | 50                              | 100                             | –                                             | $\mu\text{A}$ |
| DC Current Gain<br>( $V_{\text{CE}} = 2.0\text{ V}$ , $I_C = 350\text{ mA}$ )                                                                                                                                                                                                                                                                                                                                                                                                  | $h_{\text{FE}}$      | 1000                            | –                               | –                                             | –             |
| Input Capacitance                                                                                                                                                                                                                                                                                                                                                                                                                                                              | $C_I$                | –                               | 15                              | 30                                            | pF            |
| Turn–On Delay Time<br>(50% $E_I$ to 50% $E_O$ )                                                                                                                                                                                                                                                                                                                                                                                                                                | $t_{\text{on}}$      | –                               | 0.25                            | 1.0                                           | $\mu\text{s}$ |
| Turn–Off Delay Time<br>(50% $E_I$ to 50% $E_O$ )                                                                                                                                                                                                                                                                                                                                                                                                                               | $t_{\text{off}}$     | –                               | 0.25                            | 1.0                                           | $\mu\text{s}$ |
| Clamp Diode Leakage Current<br>( $V_R = 50\text{ V}$ )                                                                                                                                                                                                                                                                                                                                                                                                                         | $I_R$                | –<br>–                          | –<br>–                          | 50<br>100                                     | $\mu\text{A}$ |
| Clamp Diode Forward Voltage<br>( $I_F = 350\text{ mA}$ )                                                                                                                                                                                                                                                                                                                                                                                                                       | $V_F$                | –                               | 1.5                             | 2.0                                           | V             |

# MC1413, B MC1416, B

TYPICAL PERFORMANCE CURVES –  $T_A = 25^\circ\text{C}$

Figure 1. Output Current versus Input Voltage

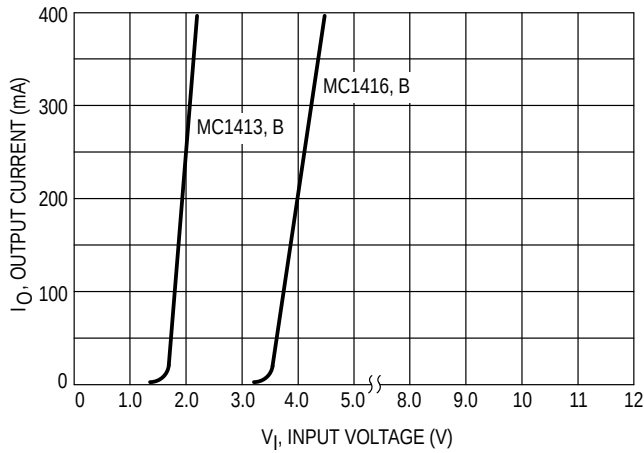


Figure 2. Output Current versus Input Current

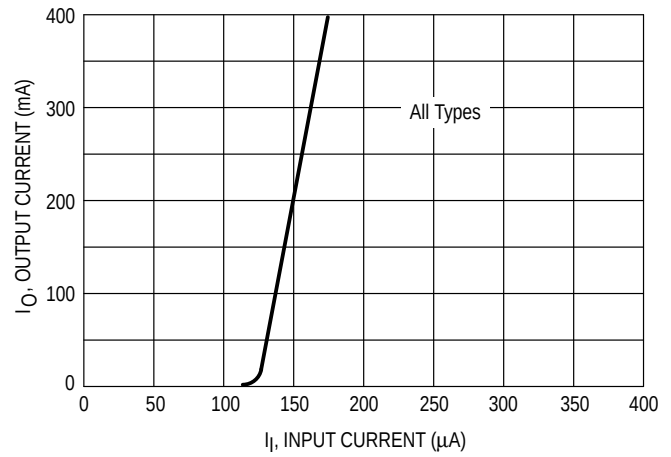


Figure 3. Typical Output Characteristics

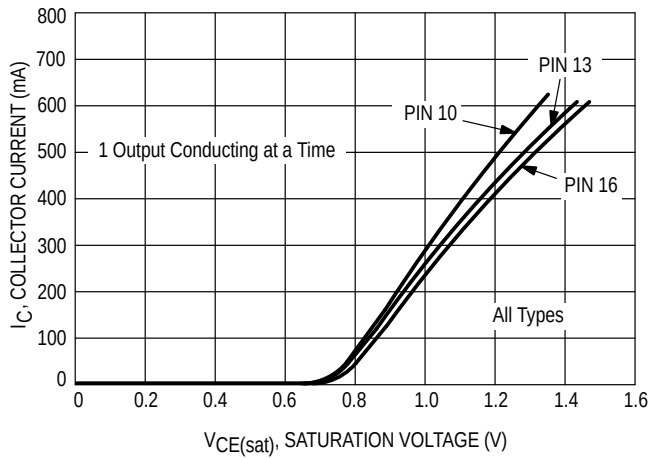


Figure 4. Input Characteristics – MC1413, B

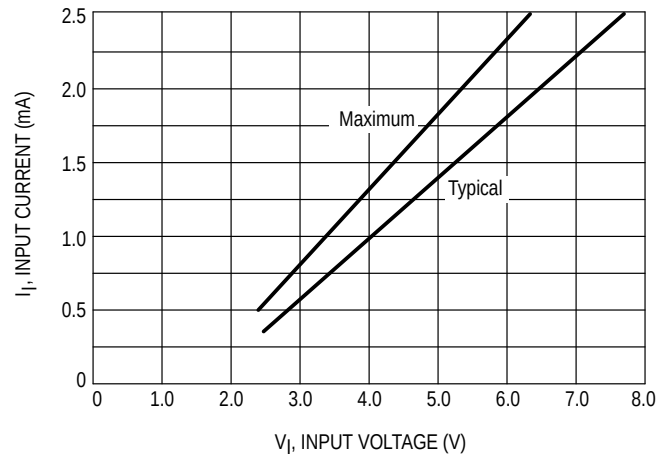


Figure 5. Input Characteristics – MC1416, B

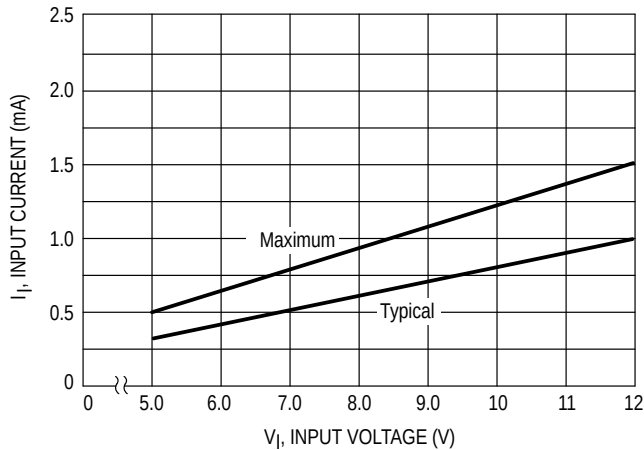
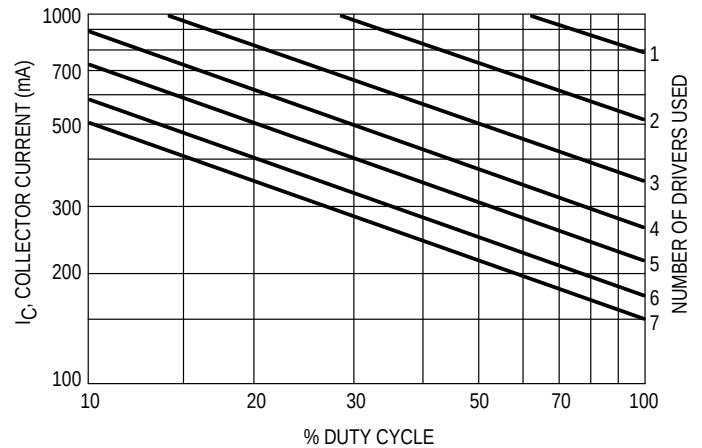


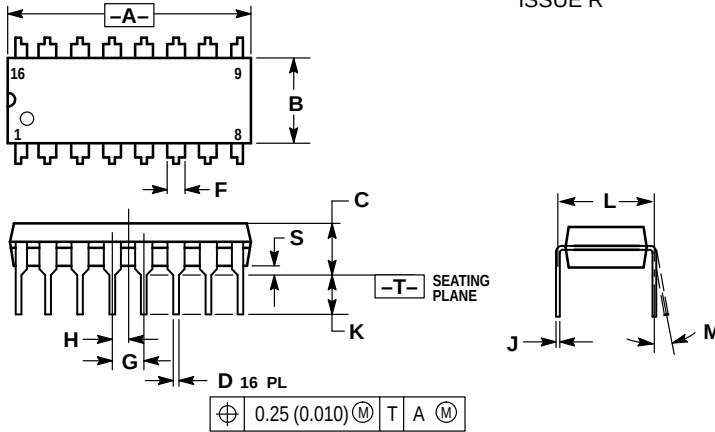
Figure 6. Maximum Collector Current versus Duty Cycle (and Number of Drivers in Use)



# MC1413, B MC1416, B

## OUTLINE DIMENSIONS

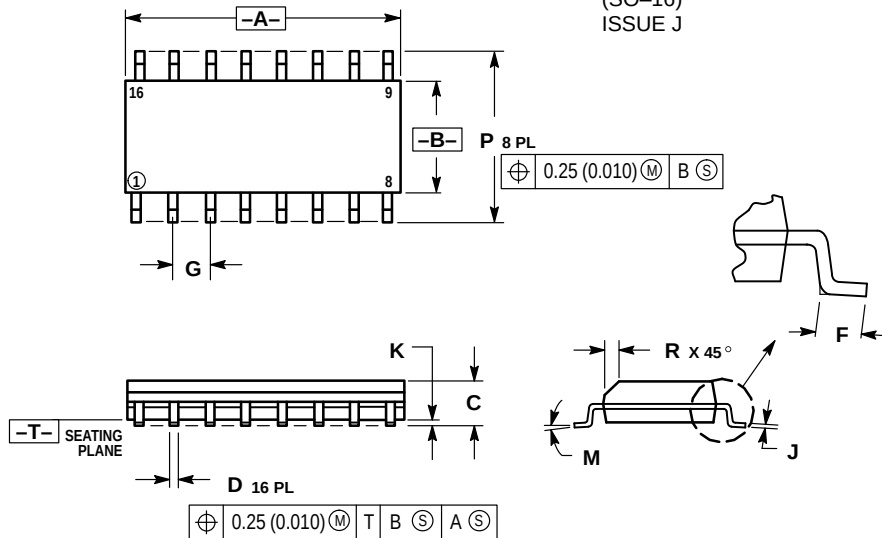
### P SUFFIX PLASTIC PACKAGE CASE 648-08 ISSUE R



- 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. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.740     | 0.770 | 18.80       | 19.55 |
| B   | 0.250     | 0.270 | 6.35        | 6.85  |
| C   | 0.145     | 0.175 | 3.69        | 4.44  |
| D   | 0.015     | 0.021 | 0.39        | 0.53  |
| F   | 0.040     | 0.70  | 1.02        | 1.77  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.050 BSC |       | 1.27 BSC    |       |
| J   | 0.008     | 0.015 | 0.21        | 0.38  |
| K   | 0.110     | 0.130 | 2.80        | 3.30  |
| L   | 0.295     | 0.305 | 7.50        | 7.74  |
| M   | 0°        | 10°   | 0°          | 10°   |
| S   | 0.020     | 0.040 | 0.51        | 1.01  |

### D SUFFIX PLASTIC PACKAGE CASE 751B-05 (SO-16) ISSUE J



- 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 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | 9.80        | 10.00 | 0.386     | 0.393 |
| B   | 3.80        | 4.00  | 0.150     | 0.157 |
| C   | 1.35        | 1.75  | 0.054     | 0.068 |
| D   | 0.35        | 0.49  | 0.014     | 0.019 |
| F   | 0.40        | 1.25  | 0.016     | 0.049 |
| G   | 1.27 BSC    |       | 0.050 BSC |       |
| J   | 0.19        | 0.25  | 0.008     | 0.009 |
| K   | 0.10        | 0.25  | 0.004     | 0.009 |
| M   | 0°          | 7°    | 0°        | 7°    |
| P   | 5.80        | 6.20  | 0.229     | 0.244 |
| R   | 0.25        | 0.50  | 0.010     | 0.019 |

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