

# MM54HCT640/MM74HCT640 Inverting Octal TRI-STATE® Transceiver MM54HCT643/MM74HCT643 True-Inverting Octal TRI-STATE Transceiver

## General Description

These TRI-STATE bi-directional transceivers utilize advanced silicon-gate CMOS technology and are intended for two-way asynchronous communication between data buses. They have high drive current outputs which enable high speed operation even when driving large bus capacitances. These circuits possess the low power consumption of CMOS circuitry, yet have speeds comparable to low power Schottky TTL circuits.

All devices are TTL input compatible and can drive up to 15 LS-TTL loads, and all inputs are protected from damage due to static discharge by diodes to  $V_{CC}$  and ground.

Both the MM54HCT640/MM74HCT640 and the MM54HCT643/MM74HCT643 have one active low enable input ( $\bar{G}$ ), and a direction control (DIR). When the DIR input is high, data flows from the A inputs to the B outputs. When DIR is low, data flows from B to A. The MM54HCT640/

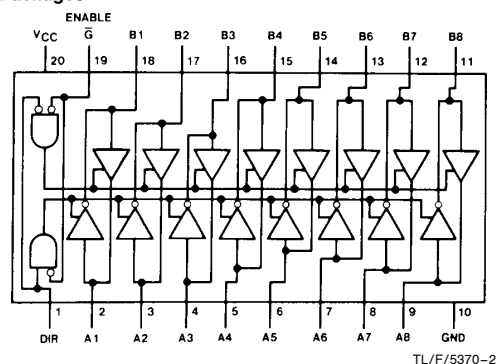
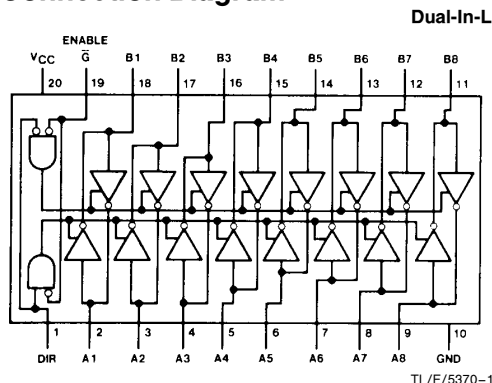
MM74HCT640 transfers inverted data from one bus to the other. The MM54HCT643/MM74HCT643 transfers inverted data from the A bus to the B bus and non-inverted data from the B bus to the A bus.

MM54HCT/MM74HCT devices are intended to interface between TTL and NMOS components and standard CMOS devices. These parts are also plug-in replacements for LS-TTL devices and can be used to reduce power consumption in existing designs.

## Features

- TTL input compatible
- Octal TRI-STATE outputs for  $\mu P$  bus applications: 6 mA, typical
- High speed: 16 ns typical propagation delay
- Low power: 80  $\mu A$  maximum (74HCT)

## Connection Diagram



## Truth Table

| Control Inputs |     | Operation               |                         |
|----------------|-----|-------------------------|-------------------------|
| $\bar{G}$      | DIR | 640                     | 643                     |
| L              | L   | $\bar{B}$ data to A bus | B data to A bus         |
| L              | H   | $\bar{A}$ data to B bus | $\bar{A}$ data to B bus |
| H              | X   | Isolation               | Isolation               |

H = high level, L = low level, X = irrelevant

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**Absolute Maximum Ratings** (Notes 1 & 2)

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

|                                                  |                         |
|--------------------------------------------------|-------------------------|
| Supply Voltage ( $V_{CC}$ )                      | −0.5 to +7.0V           |
| DC Input Voltage ( $V_{IN}$ )                    | −1.5 to $V_{CC} + 1.5V$ |
| DC Output Voltage ( $V_{OUT}$ )                  | −0.5 to $V_{CC} + 0.5V$ |
| Clamp Diode Current ( $I_{IK}, I_{OK}$ )         | ±20 mA                  |
| DC Output Current, per pin ( $I_{OUT}$ )         | ±35 mA                  |
| DC $V_{CC}$ or GND Current, per pin ( $I_{CC}$ ) | ±70 mA                  |
| Storage Temperature Range ( $T_{STG}$ )          | −65°C to +150°C         |
| Power Dissipation ( $P_D$ )                      |                         |
| (Note 3)                                         | 600 mW                  |
| S.O. Package only                                | 500 mW                  |
| Lead Temperature ( $T_L$ )                       |                         |
| (Soldering 10 seconds)                           | 260°C                   |

**Operating Conditions**

|                                                  | Min | Max      | Units |
|--------------------------------------------------|-----|----------|-------|
| Supply Voltage ( $V_{CC}$ )                      | 4.5 | 5.5      | V     |
| DC Input or Output Voltage ( $V_{IN}, V_{OUT}$ ) | 0   | $V_{CC}$ | V     |
| Operating Temp. Range ( $T_A$ )                  |     |          |       |
| MM74HCT                                          | −40 | +85      | °C    |
| MM54HCT                                          | −55 | +125     | °C    |
| Input Rise or Fall Times ( $t_r, t_f$ )          |     | 500      | ns    |

**DC Electrical Characteristics**  $V_{CC} = 5V \pm 10\%$  (unless otherwise specified)

| Symbol          | Parameter                                | Conditions                                                                                                                                                                                        | T <sub>A</sub> = 25°C         |                                      | 74HCT<br>T <sub>A</sub> = −40 to 85°C | 54HCT<br>T <sub>A</sub> = −55 to 125°C | Units       |
|-----------------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|--------------------------------------|---------------------------------------|----------------------------------------|-------------|
|                 |                                          |                                                                                                                                                                                                   | Typ                           | Guaranteed Limits                    |                                       |                                        |             |
| V <sub>IH</sub> | Minimum High Level Input Voltage         |                                                                                                                                                                                                   |                               | 2.0                                  | 2.0                                   | 2.0                                    | V           |
| V <sub>IL</sub> | Maximum Low Level Input Voltage          |                                                                                                                                                                                                   |                               | 0.8                                  | 0.8                                   | 0.8                                    | V           |
| V <sub>OH</sub> | Minimum High Level Output Voltage        | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   = 20 μA<br> I <sub>OUT</sub>   = 6.0mA, V <sub>CC</sub> = 4.5V<br> I <sub>OUT</sub>   = 7.2mA, V <sub>CC</sub> = 5.5V | V <sub>CC</sub><br>4.2<br>5.2 | V <sub>CC</sub> -0.1<br>3.98<br>4.98 | V <sub>CC</sub> -0.1<br>3.84<br>4.84  | V <sub>CC</sub> -0.1<br>3.7<br>4.7     | V<br>V<br>V |
| V <sub>OL</sub> | Maximum Low Level Voltage                | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br> I <sub>OUT</sub>   = 20 μA<br> I <sub>OUT</sub>   = 6.0mA, V <sub>CC</sub> = 4.5V<br> I <sub>OUT</sub>   = 7.2mA, V <sub>CC</sub> = 5.5V | 0<br>0.2<br>0.2               | 0.1<br>0.26<br>0.26                  | 0.1<br>0.33<br>0.33                   | 0.1<br>0.4<br>0.4                      | V<br>V<br>V |
| I <sub>IN</sub> | Maximum Input Current                    | V <sub>IN</sub> = V <sub>CC</sub> or GND,<br>V <sub>IH</sub> or V <sub>IL</sub>                                                                                                                   |                               | ±0.1                                 | ±1.0                                  | ±1.0                                   | μA          |
| I <sub>OZ</sub> | Maximum TRI-STATE Output Leakage Current | V <sub>OUT</sub> = V <sub>CC</sub> or GND<br>Enable $\bar{G}$ = V <sub>IH</sub>                                                                                                                   |                               | ±0.5                                 | ±5.0                                  | ±10                                    | μA          |
| I <sub>CC</sub> | Maximum Quiescent Supply Current         | V <sub>IN</sub> = V <sub>CC</sub> or GND<br>I <sub>OUT</sub> = 0μA                                                                                                                                |                               | 8                                    | 80                                    | 160                                    | μA          |
|                 |                                          | V <sub>IN</sub> = 2.4V or 0.5V<br>(Note 4)                                                                                                                                                        | 0.6                           | 1.0                                  | 1.3                                   | 1.5                                    | mA          |

**Note 1:** Absolute Maximum Ratings are those values beyond which damage to the device may occur.

**Note 2:** Unless otherwise specified all voltages are referenced to ground.

**Note 3:** Power Dissipation temperature derating — plastic "N" package: −12 mW/°C from 65°C to 85°C; ceramic "J" package: −12 mW/°C from 100°C to 125°C.

**Note 4:** Measured per input. All other inputs held at  $V_{CC}$  or ground.

**AC Electrical Characteristics** MM54HCT640/MM74HCT640

$V_{CC} = 5.0V$ ,  $t_r = t_f = 6$  ns,  $T_A = 25^\circ C$  (unless otherwise specified)

| Symbol             | Parameter                        | Conditions                    | Typ | Guaranteed Limits | Units |
|--------------------|----------------------------------|-------------------------------|-----|-------------------|-------|
| $t_{PHL}, t_{PLH}$ | Maximum Output Propagation Delay | $C_L = 45$ pF                 | 16  | 20                | ns    |
| $t_{PZL}, t_{PZH}$ | Maximum Output Enable Time       | $C_L = 45$ pF<br>$R_L = 1$ kΩ | 29  | 40                | ns    |
| $t_{PLZ}, t_{PHZ}$ | Maximum Output Disable Time      | $C_L = 5$ pF<br>$R_L = 1$ kΩ  | 20  | 25                | ns    |

## AC Electrical Characteristics MM54HCT640/MM74HCT640

$V_{CC} = 5.0V \pm 10\%$ ,  $t_r = t_f = 6\text{ ns}$  (unless otherwise specified)

| Symbol                              | Parameter                              | Conditions              |                                                          | T <sub>A</sub> = 25°C |                   | 74HCT                         | 54HCT                          | Units |
|-------------------------------------|----------------------------------------|-------------------------|----------------------------------------------------------|-----------------------|-------------------|-------------------------------|--------------------------------|-------|
|                                     |                                        |                         |                                                          |                       |                   | T <sub>A</sub> = − 40 to 85°C | T <sub>A</sub> = − 55 to 125°C |       |
|                                     |                                        |                         |                                                          | Typ                   | Guaranteed Limits |                               |                                |       |
| t <sub>PHL</sub> , t <sub>PLH</sub> | Maximum Output Propagation Delay       | C <sub>L</sub> = 50 pF  |                                                          | 17                    | 23                | 29                            | 34                             | ns    |
|                                     |                                        | C <sub>L</sub> = 150 pF |                                                          | 24                    | 30                | 38                            | 45                             | ns    |
| t <sub>PZH</sub> , t <sub>PZL</sub> | Maximum Output Enable Time             | R <sub>L</sub> = 1kΩ    | C <sub>L</sub> = 50 pF                                   | 23                    | 30                | 38                            | 45                             | ns    |
| t <sub>PHZ</sub> , t <sub>PLZ</sub> | Maximum Output Disable Time            | R <sub>L</sub> = 1kΩ    | C <sub>L</sub> = 50 pF                                   | 21                    | 30                | 38                            | 45                             | ns    |
| t <sub>THL</sub> , t <sub>TLH</sub> | Maximum Output Rise and Fall Time      | C <sub>L</sub> = 50 pF  |                                                          | 8                     | 12                | 15                            | 18                             | ns    |
| C <sub>IN</sub>                     | Maximum Input Capacitance              |                         |                                                          | 10                    | 15                | 15                            | 15                             | pF    |
| C <sub>OUT</sub>                    | Maximum Output/ Input Capacitance      |                         |                                                          | 20                    | 25                | 25                            | 25                             | pF    |
| C <sub>PD</sub>                     | Power Dissipation Capacitance (Note 5) | (per output)            | $\overline{G}$ = V <sub>CC</sub><br>$\overline{G}$ = GND | 7                     |                   |                               |                                | pF    |
|                                     |                                        |                         |                                                          | 100                   |                   |                               |                                | pF    |

## AC Electrical Characteristics MM54HCT643/MM74HCT643

$V_{CC} = 5.0V$ ,  $t_r = t_f = 6\text{ ns}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise specified)

| Symbol             | Parameter                        | Conditions                                       | Typ | Guaranteed Limits | Units |
|--------------------|----------------------------------|--------------------------------------------------|-----|-------------------|-------|
| $t_{PHL}, t_{PLH}$ | Maximum Output Propagation Delay | $C_L = 45\text{ pF}$                             | 16  | 20                | ns    |
| $t_{PZL}, t_{PZH}$ | Maximum Output Enable Time       | $C_L = 45\text{ pF}$<br>$R_L = 1\text{ k}\Omega$ | 29  | 40                | ns    |
| $t_{PLZ}, t_{PHZ}$ | Maximum Output Disable Time      | $C_L = 5\text{ pF}$<br>$R_L = 1\text{ k}\Omega$  | 20  | 25                | ns    |

## AC Electrical Characteristics MM54HCT643/MM74HCT643

$V_{CC} = 5.0V \pm 10\%$ ,  $t_r = t_f = 6\text{ ns}$  (unless otherwise specified)

| Symbol                              | Parameter                              | Conditions              |                                                 | T <sub>A</sub> = 25°C |                   | 74HCT | 54HCT | Units    |
|-------------------------------------|----------------------------------------|-------------------------|-------------------------------------------------|-----------------------|-------------------|-------|-------|----------|
|                                     |                                        |                         |                                                 | Typ                   | Guaranteed Limits |       |       |          |
| t <sub>PHL</sub> , t <sub>PLH</sub> | Maximum Output Propagation Delay       | C <sub>L</sub> = 50 pF  |                                                 | 17                    | 23                | 29    | 34    | ns       |
|                                     |                                        | C <sub>L</sub> = 150 pF |                                                 | 24                    | 30                | 38    | 45    | ns       |
| t <sub>PZH</sub> , t <sub>PZL</sub> | Maximum Output Enable Time             | R <sub>L</sub> = 1 kΩ   | C <sub>L</sub> = 50 pF                          | 23                    | 30                | 38    | 45    | ns       |
| t <sub>PHZ</sub> , t <sub>PLZ</sub> | Maximum Output Disable Time            | R <sub>L</sub> = 1 kΩ   | C <sub>L</sub> = 50 pF                          | 21                    | 30                | 38    | 45    | ns<br>ns |
| t <sub>THL</sub> , t <sub>TLH</sub> | Maximum Output Rise and Fall Time      | C <sub>L</sub> = 50 pF  |                                                 | 8                     | 12                | 15    | 18    | ns       |
| C <sub>IN</sub>                     | Maximum Input Capacitance              |                         |                                                 | 10                    | 15                | 15    | 15    | pF       |
| C <sub>OUT</sub>                    | Maximum Output/ Input Capacitance      |                         |                                                 | 20                    | 25                | 25    | 25    | pF       |
| C <sub>PD</sub>                     | Power Dissipation Capacitance (Note 5) | (per output)            | $\overline{G} = V_{CC}$<br>$\overline{G} = GND$ | 7                     |                   |       |       | pF       |
|                                     |                                        |                         |                                                 | 100                   |                   |       |       | pF       |

**Note 5:**  $C_{PD}$  determines the no load power consumption.  $P_D = C_{PD}V_{CC}^2f + I_{CC}V_{CC}$ . The no load dynamic current consumption,  $I_S = C_{PD}V_{CC} + I_{CC}$ .

