

High-Speed CMOS Logic Octal Three-State Bus Transceiver, Inverting

Features

- Buffered Inputs
- Three-State Outputs
- Applications in Multiple-Data-Bus Architecture
- Fanout (Over Temperature Range)
 - Standard Outputs 10 LSTTL Loads
 - Bus Driver Outputs 15 LSTTL Loads
- Wide Operating Temperature Range . . . -55°C to 125°C
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- HC Types
 - 2V to 6V Operation
 - High Noise Immunity: $N_{IL} = 30\%$, $N_{IH} = 30\%$ of V_{CC} at $V_{CC} = 5V$
- HCT Types
 - 4.5V to 5.5V Operation
 - Direct LSTTL Input Logic Compatibility, $V_{IL} = 0.8V$ (Max), $V_{IH} = 2V$ (Min)
 - CMOS Input Compatibility, $I_I \leq 1\mu A$ at V_{OL} , V_{OH}

Description

The 'HC640 and 'HCT640 silicon-gate CMOS three-state bidirectional inverting and non-inverting buffers are intended for two-way asynchronous communication between data buses. They have high drive current outputs which enable high-speed operation when driving large bus capacitances. These circuits possess the low power dissipation of CMOS circuits, and have speeds comparable to low power Schottky TTL circuits. They can drive 15 LSTTL loads. The 'HC640 and 'HCT640 are inverting buffers.

The direction of data flow (A to B, B to A) is controlled by the DIR input.

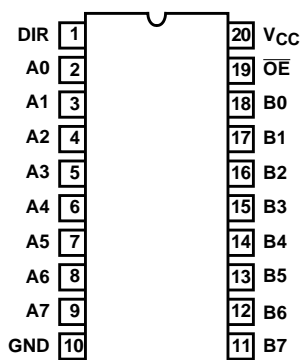
Outputs are enabled by a low on the Output Enable input (\overline{OE}); a high \overline{OE} puts these devices in the high impedance mode.

Ordering Information

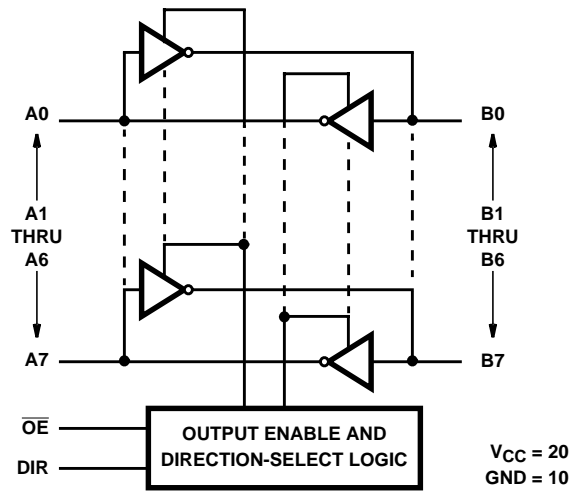
PART NUMBER	TEMP. RANGE (°C)	PACKAGE
CD54HC640F3A	-55 to 125	20 Ld CERDIP
CD54HCT640F3A	-55 to 125	20 Ld CERDIP
CD74HC640E	-55 to 125	20 Ld PDIP
CD74HC640M	-55 to 125	20 Ld SOIC
CD74HCT640E	-55 to 125	20 Ld PDIP
CD74HCT640M	-55 to 125	20 Ld SOIC

Pinout

CD54HC640, CD54HCT640
(CERDIP)
CD74HC640, CD74HCT640
(PDIP, SOIC)
TOP VIEW



Functional Diagram



TRUTH TABLE

CONTROL INPUTS		DATA PORT STATUS	
\overline{OE}	DIR	A_n	B_n
L	L	\overline{O}	I
H	H	Z	Z
H	L	Z	Z
L	H	I	\overline{O}

To prevent excess currents in the High-Z modes all I/O terminals should be terminated with 1k Ω to 1M Ω resistors.

H = High Level

L = Low Level

I = Input

\overline{O} = Output (Inversion of Input Level)

Z = High Impedance

CD54HC640, CD74HC640, CD54HCT640, CD74HCT640

Absolute Maximum Ratings

DC Supply Voltage, V_{CC}	-0.5V to 7V
DC Input Diode Current, I_{IK}	
For $V_I < -0.5V$ or $V_I > V_{CC} + 0.5V$	$\pm 20mA$
DC Output Diode Current, I_{OK}	
For $V_O < -0.5V$ or $V_O > V_{CC} + 0.5V$	$\pm 20mA$
DC Drain Current, per Output, I_O	
For $-0.5V < V_O < V_{CC} + 0.5V$	$\pm 35mA$
DC Output Source or Sink Current per Output Pin, I_O	
For $V_O > -0.5V$ or $V_O < V_{CC} + 0.5V$	$\pm 25mA$
DC V_{CC} or Ground Current, I_{CC}	$\pm 50mA$

Thermal Information

Thermal Resistance (Typical, Note 1)	θ_{JA} ($^{\circ}C/W$)
E (PDIP) Package	69
M (SOIC) Package	58
Maximum Junction Temperature	$150^{\circ}C$
Maximum Storage Temperature Range	$-65^{\circ}C$ to $150^{\circ}C$
Maximum Lead Temperature (Soldering 10s)	$300^{\circ}C$ (SOIC - Lead Tips Only)

Operating Conditions

Temperature Range, T_A	$-55^{\circ}C$ to $125^{\circ}C$
Supply Voltage Range, V_{CC}	
HC Types2V to 6V
HCT Types	4.5V to 5.5V
DC Input or Output Voltage, V_I, V_O	0V to V_{CC}
Input Rise and Fall Time	
2V	1000ns (Max)
4.5V	500ns (Max)
6V	400ns (Max)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

- The package thermal impedance is calculated in accordance with JESD 51-7.

DC Electrical Specifications

PARAMETER	SYMBOL	TEST CONDITIONS		V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS	
		V_I (V)	I_O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX		
HC TYPES													
High Level Input Voltage	V_{IH}	-	-	2	1.5	-	-	1.5	-	1.5	-	V	
				4.5	3.15	-	-	3.15	-	3.15	-	V	
				6	4.2	-	-	4.2	-	4.2	-	V	
Low Level Input Voltage	V_{IL}	-	-	2	-	-	0.5	-	0.5	-	0.5	V	
				4.5	-	-	1.35	-	1.35	-	1.35	V	
				6	-	-	1.8	-	1.8	-	1.8	V	
High Level Output Voltage CMOS Loads	V_{OH}	V_{IH} or V_{IL}	-0.02	-0.02	2	1.9	-	-	1.9	-	1.9	-	V
			-0.02	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
			-0.02	-0.02	6	5.9	-	-	5.9	-	5.9	-	V
High Level Output Voltage TTL Loads	V_{OH}	V_{IH} or V_{IL}	-	-	-	-	-	-	-	-	-	V	
			-6	-6	4.5	3.98	-	-	3.84	-	3.7	-	V
			-7.8	-7.8	6	5.48	-	-	5.34	-	5.2	-	V
Low Level Output Voltage CMOS Loads	V_{OL}	V_{IH} or V_{IL}	0.02	0.02	2	-	-	0.1	-	0.1	-	0.1	V
			0.02	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
			0.02	0.02	6	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads	V_{OL}	V_{IH} or V_{IL}	-	-	-	-	-	-	-	-	-	V	
			6	6	4.5	-	-	0.26	-	0.33	-	0.4	V
			7.8	7.8	6	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I_I	V_{CC} or GND	-	6	-	-	± 0.1	-	± 1	-	± 1	μA	

CD54HC640, CD74HC640, CD54HCT640, CD74HCT640

DC Electrical Specifications (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS		V _{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
		V _I (V)	I _O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
Quiescent Device Current	I _{CC}	V _{CC} or GND	0	6	-	-	8	-	80	-	160	μA
Three-State Leakage Current	I _{OZ}	V _{IL} or V _{IH}	V _O = V _{CC} or GND	6	-	-	±0.5	-	±5	-	±10	μA
HCT TYPES												
High Level Input Voltage	V _{IH}	-	-	4.5 to 5.5	2	-	-	2	-	2	-	V
Low Level Input Voltage	V _{IL}	-	-	4.5 to 5.5	-	-	0.8	-	0.8	-	0.8	V
High Level Output Voltage CMOS Loads	V _{OH}	V _{IH} or V _{IL}	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
High Level Output Voltage TTL Loads			-6	4.5	3.98	-	-	3.84	-	3.7	-	V
Low Level Output Voltage CMOS Loads	V _{OL}	V _{IH} or V _{IL}	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads			6	4.5	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I _I	V _{CC} and GND	0	5.5	-	-	±0.1	-	±1	-	±1	μA
Quiescent Device Current	I _{CC}	V _{CC} or GND	0	5.5	-	-	8	-	80	-	160	μA
Three-State Leakage Current	I _{OZ}	V _{IL} or V _{IH}	V _O = V _{CC} or GND	5.5	-	-	±0.5	-	±5	-	±10	μA
Additional Quiescent Device Current Per Input Pin: 1 Unit Load	ΔI _{CC} (Note 2)	V _{CC} -2.1	-	4.5 to 5.5	-	100	360	-	450	-	490	μA

NOTE:

2. For dual-supply systems theoretical worst case (V_I = 2.4V, V_{CC} = 5.5V) specification is 1.8mA.

HCT Input Loading Table

INPUT	UNIT LOADS
DIR	0.9
\overline{OE} , A	1.5
B	1.5

NOTE: Unit Load is ΔI_{CC} limit specified in DC Electrical Table, e.g., 360μA max at 25°C.

CD54HC640, CD74HC640, CD54HCT640, CD74HCT640

Switching Specifications $C_L = 50\text{pF}$, Input $t_r, t_f = 6\text{ns}$

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
HC TYPES											
Propagation Delay A to \bar{B} B to \bar{A}	t_{PHL}, t_{PLH}	$C_L = 50\text{pF}$	2	-	-	90	-	115	-	135	ns
			4.5	-	-	18	-	23	-	27	ns
		$C_L = 15\text{pF}$	5	-	7	-	-	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	-	15	-	20	-	23	ns
Output High-Z To High Level, To Low Level	t_{PHL}, t_{PLH}	$C_L = 50\text{pF}$	2	-	-	150	-	190	-	225	ns
			4.5	-	-	30	-	38	-	45	ns
		$C_L = 15\text{pF}$	5	-	12	-	-	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	-	26	-	33	-	38	ns
Output High Level Output Low Level to High Z	t_{PHZ}, t_{PLZ}	$C_L = 50\text{pF}$	2	-	-	150	-	190	-	225	ns
			4.5	-	-	30	-	38	-	45	ns
		$C_L = 15\text{pF}$	5	-	12	-	-	-	-	-	ns
		$C_L = 50\text{pF}$	6	-	-	26	-	33	-	38	ns
Output Transition Time	t_{THL}, t_{TLH}	$C_L = 50\text{pF}$	2	-	-	60	-	75	-	90	ns
			4.5	-	-	12	-	15	-	18	ns
			6	-	-	10	-	13	-	15	ns
Input Capacitance	C_{IN}	$C_L = 50\text{pF}$	-	10	-	10	-	10	-	10	pF
Three-State Output Capacitance	C_O	-	-	-	20	-	20	-	20	pF	
Power Dissipation Capacitance (Notes 3, 4)	C_{PD}	-	5	-	38	-	-	-	-	-	pF
HCT TYPES											
Propagation Delay A to \bar{B} B to \bar{A}	t_{PHL}, t_{PLH}	$C_L = 50\text{pF}$	4.5	-	-	22	-	28	-	33	ns
		$C_L = 15\text{pF}$	5	-	9	-	-	-	-	-	ns
Output High-Z To High Level, To Low Level	t_{PHL}, t_{PLH}	$C_L = 50\text{pF}$	4.5	-	-	30	-	38	-	45	ns
		$C_L = 15\text{pF}$	5	-	12	-	-	-	-	-	ns
Output High Level Output Low Level to High Z	t_{PHZ}, t_{PLZ}	$C_L = 50\text{pF}$	4.5	-	-	30	-	38	-	45	ns
		$C_L = 15\text{pF}$	5	-	12	-	-	-	-	-	ns
Output Transition Time	t_{THL}, t_{TLH}	$C_L = 50\text{pF}$	4.5	-	-	12	-	15	-	18	ns
Input Capacitance	C_{IN}	$C_L = 50\text{pF}$	-	10	-	10	-	10	-	10	pF
Three-State Output Capacitance	C_O	-	-	-	20	-	20	-	20	pF	
Power Dissipation Capacitance (Notes 3, 4)	C_{PD}	-	5	-	41	-	-	-	-	-	pF

NOTES:

- C_{PD} is used to determine the dynamic power consumption, per channel.
- $P_D = V_{CC}^2 f_i (C_{PD} + C_L)$ where f_i = Input Frequency, C_L = Output Load Capacitance, V_{CC} = Supply Voltage.

Test Circuits and Waveforms

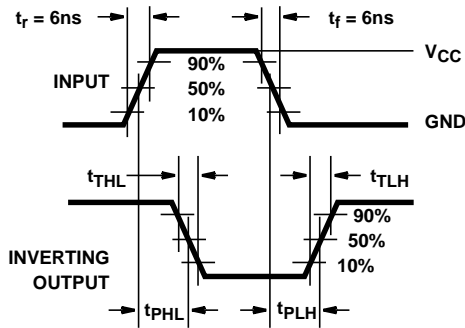


FIGURE 7. HC TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

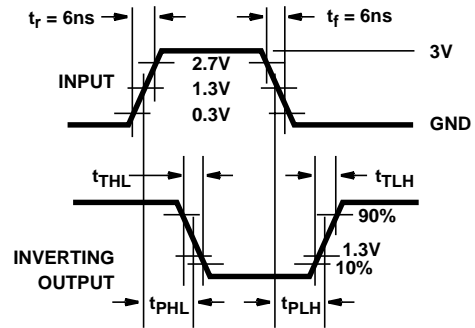


FIGURE 8. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

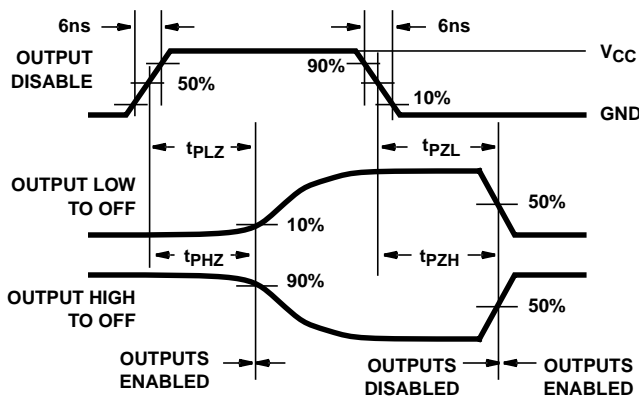


FIGURE 9. HC THREE-STATE PROPAGATION DELAY WAVEFORM

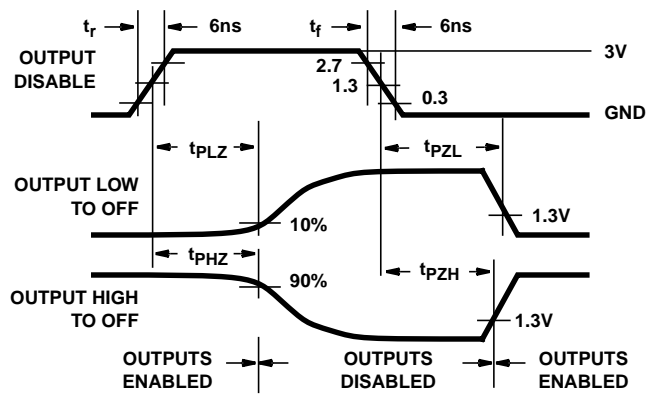
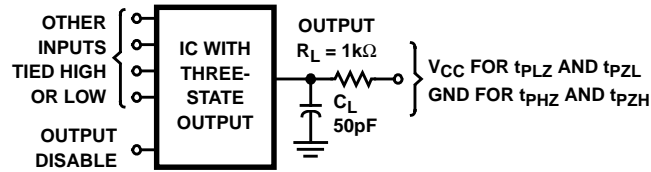


FIGURE 10. HCT THREE-STATE PROPAGATION DELAY WAVEFORM



NOTE: Open drain waveforms t_{PLZ} and t_{PZL} are the same as those for three-state shown on the left. The test circuit is Output $R_L = 1k\Omega$ V_{CC} , $C_L = 50pF$.

FIGURE 11. HC AND HCT THREE-STATE PROPAGATION DELAY TEST CIRCUIT