National Semiconductor

November 1987

MM54HCT533/MM74HCT533
TRI-STATE® Octal D-Type Latch with Inverted Outputs
MM54HCT534/MM74HCT534
TRI-STATE Octal D-Type Flip-Flop with Inverted Outputs

MM54HCT533/MM74HCT533 TRI-STATE Octal D-Type Latch with Inverted Outputs
MM54HCT534/MM74HCT534 TRI-STATE Octal D-Type Flip-Flop with Inverted Outputs

General Description

The MM54HCT533/MM74HCT533 octal D-type latches and MM54HCT534/MM74HCT534 Octal D-type flip-flops utilize advanced silicon-gate CMOS technology which provides the inherent benefits of low power consumption and wide power supply range, but are LS-TTL input and output characteristic & pin-out compatible. The TRI-STATE outputs are capable of driving 15 LS-TTL loads. All inputs are protected from damage due to static discharge by internal diodes to V_{CC} and ground.

When the MM54HCT533/MM74HCT533 LATCH ENABLE input is high, the data present on the D inputs will appear inverted at the QBar outputs. When the LATCH ENABLE goes low, the inverted data will be retained at the QBar outputs until LATCH ENABLE returns high again. When a high logic level is applied to the OUTPUT CONTROL input, all outputs go to a high impedance state, regardless of what signals are present at the other inputs and the state of the storage elements.

The MM54HCT534/MM74HCT534 are positive edge triggered flip-flops. Data at the D inputs, meeting the setup and hold time requirements, are inverted and transferred to the $\overline{Q}$ outputs on positive going transitions of the CLOCK (CK) input. When a high logic level is applied to the OUTPUT CONTROL (OC) input, all outputs go to a high impedance state, regardless of what signals are present at the other inputs and the state of the storage elements.

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 characteristic compatible
- Typical propagation delay: 18 ns
- Low input current: 1 μA maximum
- Low quiescent current: 80 μA maximum
- Compatible with bus-oriented systems
- Output drive capability: 15 LS-TTL loads

Truth Tables

'HCT533

Output Control	Latch Enable G	Data	Output
L	H	H	L
L	H	L	H
L	L	X	$\overline{Q}_0$
H	X	X	Z

'HCT534

Output Control	Clock	Data	Output
L	↑	H	L
L	↑	L	H
L	L	X	$\overline{Q}_0$
H	X	X	Z

H = High Level, L = Low Level
X = Don't Care
↑ = Transition from low-to-high
Z = High impedance state
$\overline{Q}_0$ = The level of the output before steady state Input conditions were established

TRI-STATE® is a registered trademark of National Semiconductor Corp.

 TL/F/6123

RRD-B30M105/Printed in U. S. A.

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 Temp. (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 ±10% (unless otherwise specified)

Symbol	Parameter	Conditions	T_A = 25°C	74HCT T_A = −40 to 85°C	54HCT T_A = −55 to 125°C	Units
			Typ	Guaranteed Limits		
V_{IH}	Minimum High Level Input Voltage			2.0	2.0	2.0	V
V_{IL}	Maximum Low Level Input Voltage			0.8	0.8	0.8	V
V_{OH}	Minimum High Level Output Voltage	V_{IN} = V_{IH} or V_{IL}					
		$\|I_{OUT}\|$ = 20 μA	V_{CC}	V_{CC} −0.1	V_{CC} −0.1	V_{CC} −0.1	V
		$\|I_{OUT}\|$ = 6.0 mA, V_{CC} = 4.5V	4.2	3.98	3.84	3.7	V
		$\|I_{OUT}\|$ = 7.2 mA, V_{CC} = 5.5V	5.2	4.98	4.84	4.7	V
V_{OL}	Maximum Low Level Voltage	V_{IN} = V_{IH} or V_{IL}					
		$\|I_{OUT}\|$ = 20 μA	0	0.1	0.1	0.1	V
		$\|I_{OUT}\|$ = 6.0 mA, V_{CC} = 4.5V	0.2	0.26	0.33	0.4	V
		$\|I_{OUT}\|$ = 7.2 mA, V_{CC} = 5.5V	0.2	0.26	0.33	0.4	V
I_{IN}	Maximum Input Current	V_{IN} = V_{CC} or GND, V_{IH} or V_{IL}		±0.1	±1.0	±1.0	μA
I_{OZ}	Maximum TRI-STATE Output Leakage Current	V_{OUT} = V_{CC} or GND Enable = V_{IH}		±0.5	±5.0	±10	μA
I_{CC}	Maximum Quiescent Supply Current	V_{IN} = V_{CC} or GND I_{OUT} = 0 μA		8.0	80	160	μA
		V_{IN} = 2.4V or 0.5V (Note 4)		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 pin. All others tied to V_{CC} or ground.

AC Electrical Characteristics MM54HCT533/MM74HCT533

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

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
t_{PHL}, t_{PLH}	Maximum Propagation Delay Data to Output	C_L = 45 pF	18	25	ns
t_{PHL}, t_{PLH}	Maximum Propagation Delay Latch Enable to Output	C_L = 45 pF	21	30	ns
t_{PZH}, t_{PZL}	Maximum Enable Propagation Delay Control to Output	C_L = 45 pF R_L = 1 kΩ	20	28	ns
t_{PHZ}, t_{PLZ}	Maximum Disable Propagation Delay Control to Output	C_L = 5 pF R_L = 1 kΩ	18	25	ns
t_W	Minimum Clock Pulse Width			16	ns
t_S	Minimum Setup Time Data to Clock			5	ns
t_H	Minimum Hold Time Clock to Data			10	ns

AC Electrical Characteristics MM54HCT533/MM74HCT533

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

Symbol	Parameter	Conditions	T_A = 25°C	74HCT T_A = −40 to 85°C	54HCT T_A = −55 to 125°C	Units
			Typ	Guaranteed Limits		
t_{PHL}, t_{PLH}	Maximum Propagation Delay Data to Output	C_L = 50 pF C_L = 150 pF	22 30	30 40	37 50	45 60	ns ns
t_{PHL}, t_{PLH}	Maximum Propagation Delay Latch Enable to Output	C_L = 50 pF C_L = 150 pF	25 32	35 45	44 56	53 68	ns ns
t_{PZH}, t_{PZL}	Maximum Enable Propagation Delay Control to Output	C_L = 50 pF C_L = 150 pF R_L = 1 kΩ	21 30	30 40	37 50	45 60	ns ns
t_{PHZ}, t_{PLZ}	Maximum Disable Propagation Delay Control to Output	C_L = 50 pF R_L = 1 kΩ	21	30	37	45	ns
t_{THL}, t_{TLH}	Maximum Output Rise and Fall Time	C_L = 50 pF	8	12	15	18	ns
t_W	Minimum Clock Pulse Width			16	20	24	ns
t_S	Minimum Setup Time Data to Clock			5	6	8	ns
t_H	Minimum Hold Time Clock to Data			10	13	20	ns
C_{IN}	Maximum Input Capacitance			10	10	10	pF
C_{OUT}	Maximum Output Capacitance			20	20	20	pF
C_{PD}	Power Dissipation Capacitance (Note 5)	OC = V_{CC} OC = GND	5 55				pF pF

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

AC Electrical Characteristics MM54HCT534/MM74HCT534

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

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
f_{MAX}	Maximum Clock Frequency		50	30	MHz
t_{PHL}, t_{PLH}	Maximum Propagation Delay to Output	C_L = 45 pF	20	32	ns
t_{PZH}, t_{PZL}	Maximum Enable Propagation Delay Control to Output	C_L = 45 pF R_L = 1 kΩ	19	28	ns
t_{PHZ}, t_{PLZ}	Maximum Disable Propagation Delay Control to Output	C_L = 5 pF R_L = 1 kΩ	17	25	ns
t_W	Minimum Clock Pulse Width			20	ns
t_S	Minimum Setup Time Data to Clock			5	ns
t_H	Minimum Hold Time Clock to Data			16	ns

AC Electrical Characteristics MM54HCT534/MM74HCT534

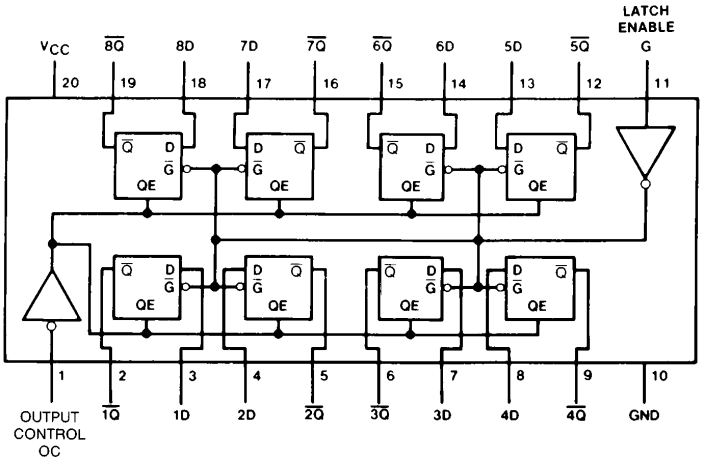
V_{CC} = 5.0V ±10%, $t_r = t_f$ = 6 ns (unless otherwise specified)

Symbol	Parameter	Conditions	T_A = 25°C	74HCT T_A = −40 to 85°C	54HCT T_A = −55 to 125°C	Units
			Typ	Guaranteed Limits		
f_{MAX}	Maximum Clock Frequency			30	24	20	MHz
t_{PHL}, t_{PLH}	Maximum Propagation Delay to Output	C_L = 50 pF C_L = 150 pF	22 30	36 46	45 57	48 69	ns ns
t_{PZH}, t_{PZL}	Maximum Enable Propagation Delay Control to Output	C_L = 50 pF C_L = 150 pF R_L = 1 kΩ	21 30	30 40	37 50	45 60	ns ns
t_{PHZ}, t_{PLZ}	Maximum Disable Propagation Delay Control to Output	C_L = 50 pF R_L = 1 kΩ	21	30	37	45	ns
t_{THL}, t_{TLH}	Maximum Output Rise and Fall Time	C_L = 50 pF	8	12	15	18	ns
t_W	Minimum Clock Pulse Width			16	20	24	ns
t_S	Minimum Setup Time Data to Clock			20	25	30	ns
t_H	Minimum Hold Time Clock to Data			5	5	5	ns
C_{IN}	Maximum Input Capacitance			10	10	10	pF
C_{OUT}	Maximum Output Capacitance			20	20	20	pF
C_{PD}	Power Dissipation Capacitance (Note 5)	OC = V_{CC} OC = GND	5 50				pF pF

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

Connection Diagram

Dual-In-Line Package

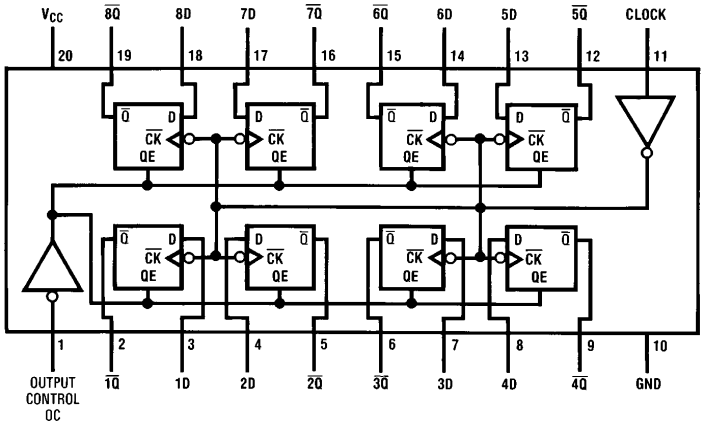


TL/F/6123–1

Top View

Order Number MM54HCT533 or MM74HCT533

Dual-In-Line Package

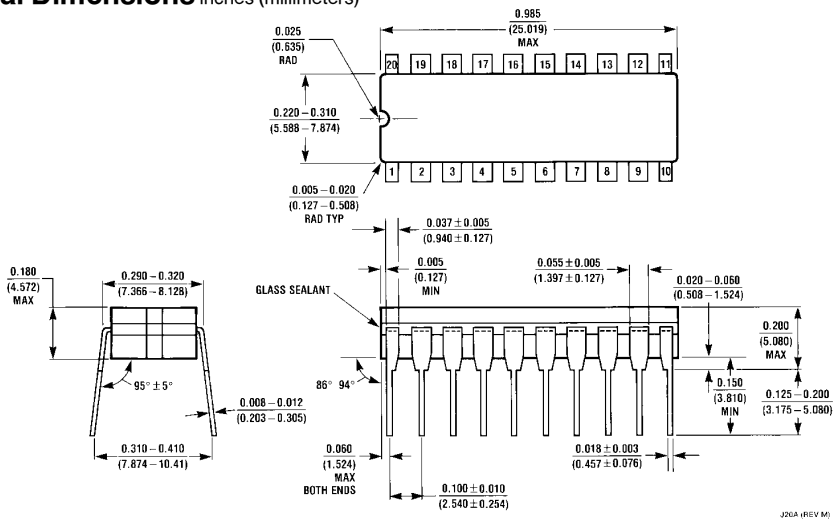


TL/F/6123–2

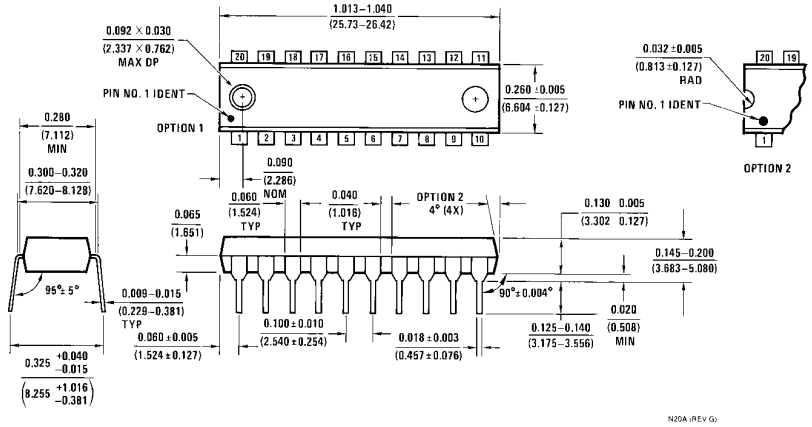
Top View

Order Number MM54HCT534 or MM74HCT534

Physical Dimensions inches (millimeters)



Order Number MM54HCT533J, MM54HCT534J, MM74HCT533J or MM74HCT534J
NS Package J20A



Order Number MM74HCT533N or MM74HCT534N
NS Package N20A

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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.
Tel: 81-043-299-2309
Fax: 81-043-299-2408