



August 1998

100351 Low Power Hex D Flip-Flop

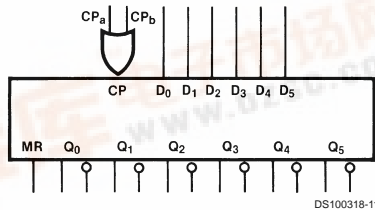
General Description

The 100351 contains six D-type edge-triggered, master/slave flip-flops with true and complement outputs, a pair of common Clock inputs (CP_a and CP_b) and common Master Reset (MR) input. Data enters a master when both CP_a and CP_b are LOW and transfers to the slave when CP_a and CP_b (or both) go HIGH. The MR input overrides all other inputs and makes the Q outputs LOW. All inputs have 50 kΩ pull-down resistors.

Features

- 40% power reduction of the 100151
- 2000V ESD protection
- Pin/function compatible with 100151
- Voltage compensated operating range: -4.2V to -5.7V
- Standard Microcircuit Drawing (SMD) 5962-9457901

Logic Symbol

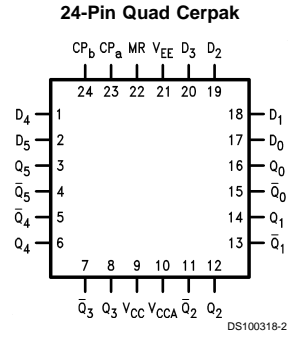
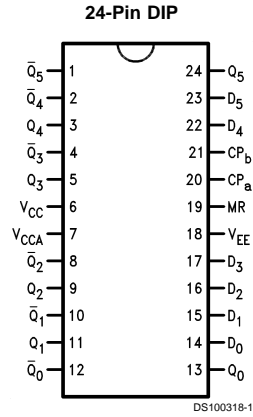


Pin Names	Description
D ₀ -D ₅	Data Inputs
CP _a , CP _b	Common Clock Inputs
MR	Asynchronous Master Reset Input
Q ₀ -Q ₅	Data Outputs
\bar{Q}_0 - \bar{Q}_5	Complementary Data Outputs

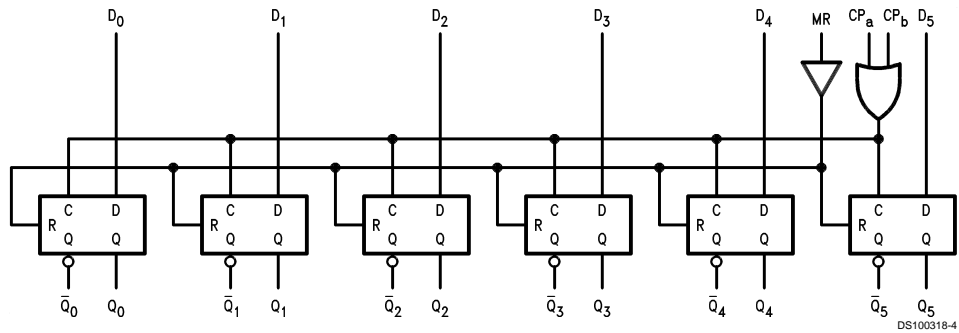
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Connection Diagrams



Logic Diagram



Truth Tables (Each Flip-flop)

Synchronous Operation

Inputs				Outputs
D_n	CP_a	CP_b	MR	$Q_n(t+1)$
L	↗	L	L	L
H	↗	L	L	H
L	L	↗	L	L
H	L	↗	L	H
X	H	↗	L	$Q_n(t)$
X	↗	H	L	$Q_n(t)$
X	L	L	L	$Q_n(t)$

Asynchronous Operation

Inputs				Outputs
D_n	CP_a	CP_b	MR	$Q_n(t+1)$
X	X	X	H	L

H = HIGH Voltage Level
 L = LOW Voltage Level
 X = Don't Care
 t = Time before CP positive transition
 t+1 = Time after CP positive transition
 ↗ = LOW-to-HIGH transition

Absolute Maximum Ratings (Note 1)

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

Above which the useful life may be impaired	
Storage Temperature (T_{STG})	-65°C to +150°C
Maximum Junction Temperature (T_J)	
Ceramic	+175°C
V_{EE} Pin Potential to Ground Pin	-7.0V to +0.5V
Input Voltage (DC)	V_{EE} to +0.5V
Output Current (DC Output HIGH)	-50 mA

ESD (Note 2)

≥2000V

Recommended Operating Conditions

Case Temperature (T_C)	
Military	-55°C to +125°C
Supply Voltage (V_{EE})	-5.7V to -4.2V

Note 1: Absolute maximum ratings are those values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

Note 2: ESD testing conforms to MIL-STD-883, Method 3015.

Military Version

DC Electrical Characteristics

$V_{EE} = -4.2V$ to $-5.7V$, $V_{CC} = V_{CCA} = GND$, $T_C = -55^\circ C$ to $+125^\circ C$

Symbol	Parameter	Min	Max	Units	T_C	Conditions	Notes	
V_{OH}	Output HIGH Voltage	-1025	-870	mV	0°C to +125°C	$V_{IN} = V_{IH}$ (Max) or V_{IL} (Min)	Loading with 50Ω to -2.0V	(Notes 3, 4, 5)
		-1085	-870	mV	-55°C			
V_{OL}	Output LOW Voltage	-1830	-1620	mV	0°C to +125°C			
		-1830	-1555	mV	-55°C			
V_{OHC}	Output HIGH Voltage	-1035		mV	0°C to +125°C	$V_{IN} = V_{IH}$ (Min) or V_{IL} (Max)	Loading with 50Ω to -2.0V	(Notes 3, 4, 5)
		-1085		mV	-55°C			
V_{OLC}	Output LOW Voltage		-1610	mV	0°C to +125°C			
			-1555	mV	-55°C			
V_{IH}	Input HIGH Voltage	-1165	-870	mV	-55°C to +125°C	Guaranteed HIGH Signal for All Inputs	(Notes 3, 4, 5, 6)	
V_{IL}	Input LOW Voltage	-1830	-1475	mV	-55°C to +125°C	Guaranteed LOW Signal for All Inputs	(Notes 3, 4, 5, 6)	
I_{IL}	Input LOW Current	0.50		μA	-55°C to +125°C	$V_{EE} = -4.2V$ $V_{IN} = V_{IL}$ (Min)	(Notes 3, 4, 5)	
I_{IH}	Input HIGH Current CP, MR D ₀ -D ₅		350	μA	0°C to +125°C	$V_{EE} = -5.7V$ $V_{IN} = V_{IH}$ (Max)	(Notes 3, 4, 5)	
			240	μA	-55°C			
I_{IH}	Input HIGH Current CP, MR D ₀ -D ₅		500	μA	-55°C			
			340	μA				
I_{EE}	Power Supply Current	-135	-50	mA	-55°C to +125°C	Inputs Open	(Notes 3, 4, 5)	

Note 3: F100K 300 Series cold temperature testing is performed by temperature soaking (to guarantee junction temperature equals -55°C), then testing immediately without allowing for the junction temperature to stabilize due to heat dissipation after power-up. This provides "cold start" specs which can be considered a worst case condition at cold temperatures.

Note 4: Screen tested 100% on each device at -55°C, +25°C, and +125°C, Subgroups 1, 2, 3, 7, and 8.

Note 5: Sample tested (Method 5005, Table I) on each manufactured lot at -55°C, +25°C, and +125°C, Subgroups A1, 2, 3, 7, and 8.

Note 6: Guaranteed by applying specified input condition and testing V_{OH}/V_{OL} .

AC Electrical Characteristics

$V_{EE} = -4.2V$ to $-5.7V$, $V_{CC} = V_{CCA} = GND$

Symbol	Parameter	$T_C = -55^\circ C$		$T_C = +25^\circ C$		$T_C = +125^\circ C$		Units	Conditions	Notes
		Min	Max	Min	Max	Min	Max			
f_{max}	Toggle Frequency	375		375		375		MHz	Figures 2, 3	(Note 10)
t_{PLH}	Propagation Delay	0.40	2.40	0.50	2.20	0.50	2.60	ns	Figures 1, 3	(Notes 7, 8, 9)
t_{PHL}	CP_a , CP_b to Output									
t_{PLH}	Propagation Delay	0.60	2.70	0.70	2.60	0.80	2.90	ns	Figures 1, 4	
t_{PHL}	MR to Output									
t_{TLH}	Transition Time	0.20	1.60	0.20	1.60	0.20	1.60	ns	Figures 1, 3	(Note 10)
t_{THL}	20% to 80%, 80% to 20%									
t_s	Setup Time									
	D_0-D_5	0.90		0.80		0.90		ns	Figure 5	
	MR (Release Time)	1.60		1.80		2.60			Figure 4	
t_h	Hold Time	1.50		1.40		1.60		ns	Figure 5	
	D_0-D_5									
$t_{pw}(H)$	Pulse Width HIGH	2.00		2.00		2.00		ns	Figures 3, 4	
	CP_a , CP_b , MR									

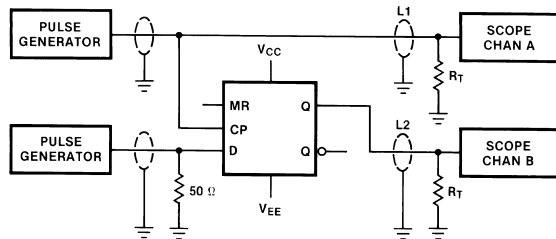
Note 7: F100K 300 Series cold temperature testing is performed by temperature soaking (to guarantee junction temperature equals $-55^\circ C$), then testing immediately without allowing for the junction temperature to stabilize due to heat dissipation after power-up. This provides "cold start" specs which can be considered a worst case condition at cold temperatures.

Note 8: Screen tested 100% on each device at $+25^\circ C$, Temperature only, Subgroup A9.

Note 9: Sample tested (Method 5005, Table I) on each Mfg. lot at $+25^\circ C$, Subgroup A9, and at $+125^\circ C$, and $-55^\circ C$ Temperature, Subgroups A10 and A11.

Note 10: Not tested at $+25^\circ C$, $+125^\circ C$ and $-55^\circ C$ Temperature (design characterization data).

Test Circuitry



DS100318-5

Notes:

V_{CC} , $V_{CCA} = +2V$, $V_{EE} = -2.5V$

L1 and L2 = equal length 50Ω impedance lines

$R_T = 50\Omega$ terminator internal to scope

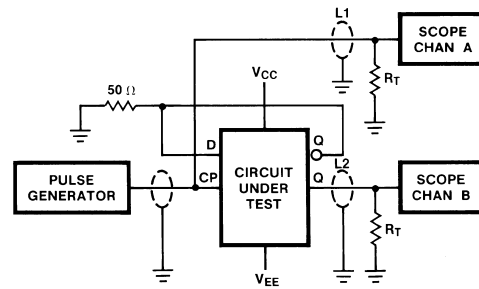
Decoupling $0.1 \mu F$ from GND to V_{CC} and V_{EE}

All unused outputs are loaded with 50Ω to GND

C_L = Fixture and stray capacitance ≤ 3 pF

FIGURE 1. AC Test Circuit

Test Circuitry (Continued)



DS100318-6

Notes:

$V_{CC}, V_{CCA} = +2V, V_{EE} = -2.5V$

L1 and L2 = equal length 50Ω impedance lines

$R_T = 50\Omega$ terminator internal to scope

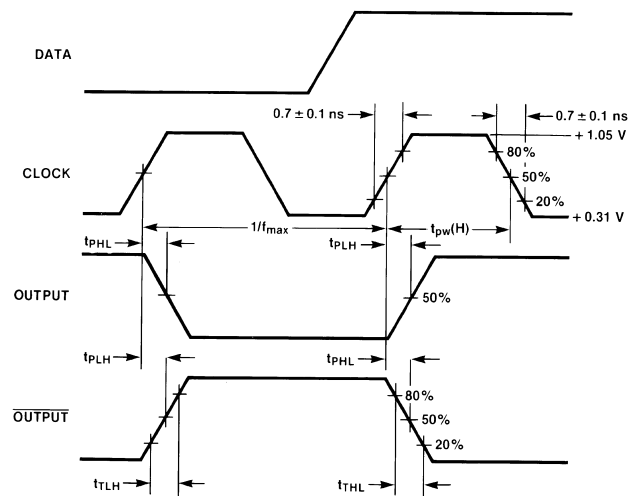
Decoupling 0.1 μF from GND to V_{CC} and V_{EE}

All unused outputs are loaded with 50Ω to GND

C_L = Jig and stray capacitance ≤ 3 pF

FIGURE 2. Toggle Frequency Test Circuit

Switching Waveforms



DS100318-7

FIGURE 3. Propagation Delay (Clock) and Transition Times

Switching Waveforms (Continued)

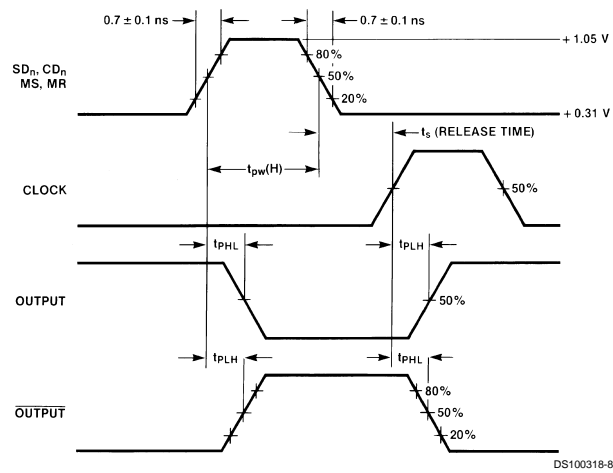
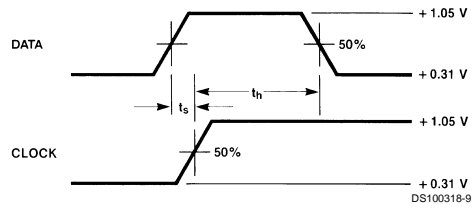


FIGURE 4. Propagation Delay (Reset)



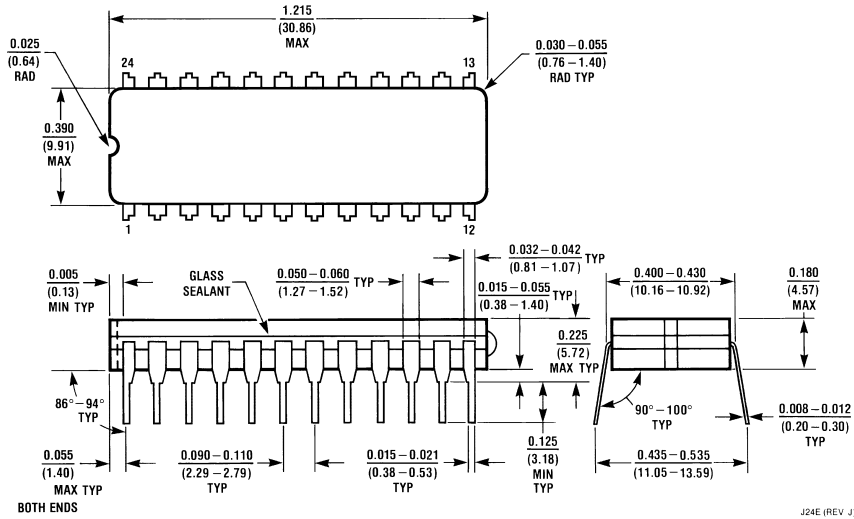
Notes:

t_s is the minimum time before the transition of the clock that information must be present at the data input.

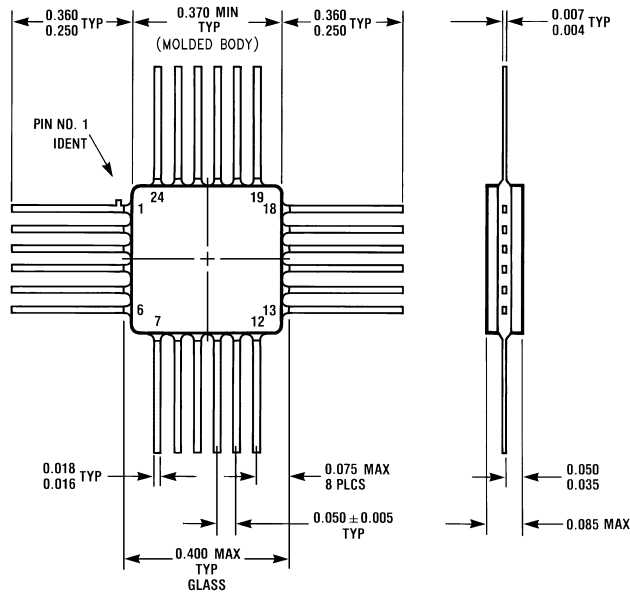
t_h is the minimum time after the transition of the clock that information must remain unchanged at the data input.

FIGURE 5. Setup and Hold Time

Physical Dimensions inches (millimeters) unless otherwise noted



24-Lead Ceramic Dual-In-Line Package (0.400" Wide) (D)
NS Package Number J24E



24-Lead Quad Cerpak (F)
NS Package Number W24B

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National Semiconductor Corporation
Americas
Tel: 1-800-272-9959
Fax: 1-800-737-7018
Email: support@nsc.com

www.national.com

National Semiconductor Europe
Fax: +49 (0) 1 80-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 1 80-530 85 85
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