National Semiconductor

August 1998

100331
Low Power Triple D Flip-Flop

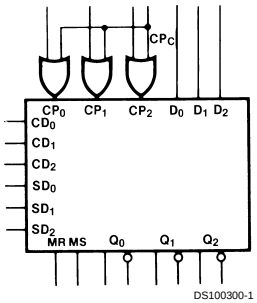
General Description

The 100331 contains three D-type, edge-triggered master/slave flip-flops with true and complement outputs, a Common Clock (CP_C), and Master Set (MS) and Master Reset (MR) inputs. Each flip-flop has individual Clock (CP_n), Direct Set (SD_n) and Direct Clear (CD_n) inputs. Data enters a master when both CP_n and CP_C are LOW and transfers to a slave when CP_n or CP_C (or both) go HIGH. The Master Set, Master Reset and individual CD_n and SD_n inputs override the Clock inputs. All inputs have 50 kΩ pull-down resistors.

Features

- 35% power reduction of the 100131
- 2000V ESD protection
- Pin/function compatible with 100131
- Voltage compensated operating range = −4.2V to −5.7V
- Available to industrial grade temperature range
- Available to Standard Microcircuit Drawing (SMD) 5962-9153601

Logic Symbol

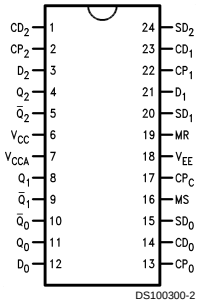


DS100300-1

Pin Names	Description
CP_0–CP_2	Individual Clock Inputs
CP_C	Common Clock Input
D_0–D_2	Data Inputs
CD_0–CD_2	Individual Direct Clear Inputs
SD_n	Individual Direct Set Inputs
MR	Master Reset Input
MS	Master Set Input
Q_0-Q_2	Data Outputs
$\overline{Q}_0$–$\overline{Q}_2$	Complementary Data Outputs

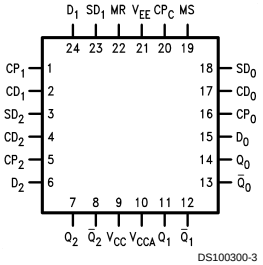
Connection Diagrams

24-Pin DIP



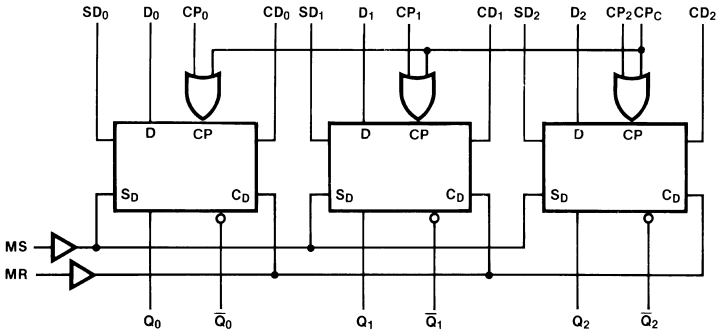
DS100300-2

24-Pin Quad Cerpak



DS100300-3

Logic Diagram



DS100300-5

Truth Tables

Synchronous Operation

(Each Flip-Flop)

Inputs					Outputs
D_n	CP_n	CP_C	MS SD_n	MR CD_n	$Q_n(t+1)$
L	⌐	L	L	L	L
H	⌐	L	L	L	H
L	L	⌐	L	L	L
H	L	⌐	L	L	H
X	L	L	L	L	Qn(t)
X	H	X	L	L	Qn(t)
X	X	H	L	L	Qn(t)

H = HIGH Voltage Level
L = LOW Voltage Level
X = Don't Care
U = Undefined
t = Time before CP Positive Transition
t + 1 = Time after CP Positive Transition
⌐ = LOW to HIGH Transition

Asynchronous Operation

(Each Flip-Flop)

Inputs					Outputs
D_n	CP_n	CP_C	MS SD_n	MR CD_n	$Q_n(t+1)$
X	X	X	H	L	H
X	X	X	L	H	L
X	X	X	H	H	U

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
Pin Potential to	
Ground Pin (V_{EE})	−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˚C to +125˚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		240	µA	0˚C to +125˚C	V_{EE} = −5.7V V_{IN} = V_{IH} (Max)		(Notes 3, 4, 5)
			340	µA	−55˚C			
I_{EE}	Power Supply Current	−130	−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: Sampled 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˚C		T_C = +25˚C		T_C = +125˚C		Units	Conditions		Notes
		Min	Max	Min	Max	Min	Max				
f_{max}	Toggle Frequency	400		400		400		MHz	*Figures 2, 3*		(Note 10)
t_{PLH} t_{PHL}	Propagation Delay CP_C to Output	0.50	2.20	0.60	2.00	0.50	2.40	ns	*Figures 1, 3*		
t_{PLH} t_{PHL}	Propagation Delay CP_n to Output	0.50	2.20	0.60	2.00	0.50	2.40	ns			
t_{PLH} t_{PHL}	Propagation Delay CD_n, SD_n to Output	0.50	2.20	0.60	2.00	0.50	2.40	ns	CP_n, CP_C = L	*Figures 1, 4*	(Notes 7, 8, 9)
t_{PLH} t_{PHL}		0.50	2.40	0.60	2.10	0.50	2.50		CP_n, CP_C = H		
t_{PLH} t_{PHL}	Propagation Delay MS, MR to Output	0.70	2.70	0.80	2.60	0.80	2.90	ns	CP_n, CP_C = L		
t_{PLH} t_{PHL}		0.70	2.90	0.80	2.80	0.80	3.10		CP_n, CP_C = H		
t_{TLH} t_{THL}	Transition Time 20% to 80%, 80% to 20%	0.20	1.40	0.20	1.40	0.20	1.40	ns	*Figures 1, 3, 4*		
t_s	Setup Time								*Figure 5*		
	D_n	1.00		0.80		0.90					(Note 10)
	CD_n, SD_n (Release Time)	1.50		1.30		1.60		ns	*Figure 4*		
	MS, MR (Release Time)	2.50		2.30		2.50					
t_h	Hold Time D_n	1.50		1.30		1.60		ns	*Figure 5*		
t_{pw}(H)	Pulse Width HIGH CP_n, CP_C, CD_n, SD_n, MR, MS	2.00		2.00		2.00		ns	*Figures 3, 4*		

Note 7: 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 8: Screen tested 100% on each device at +25˚C. Temperature only, Subgroup A9.

Note 9: Sample tested (Method 5005, Table I) on each Mfg. lot at +25˚C, Subgroup A9, and at +125˚C, and −55˚C Temp., Subgroups A10 and A11.

Note 10: Not tested at +25˚C, +125˚C and −55˚C Temperature (design characterization data).

Test Circuits

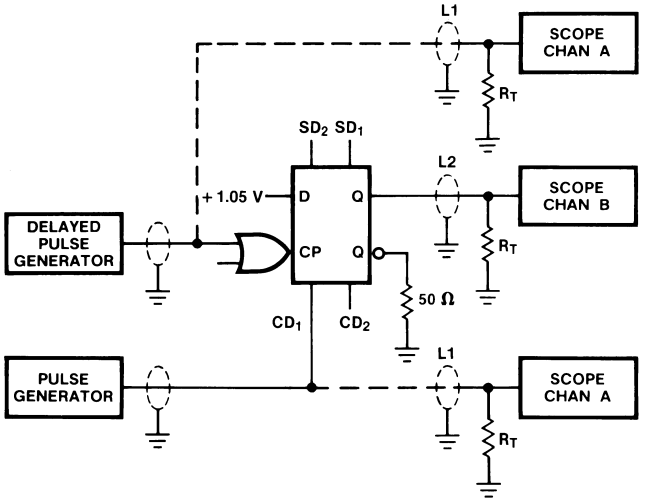
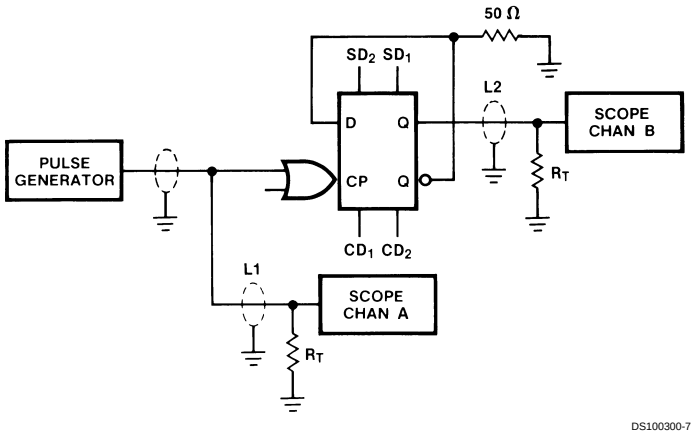


FIGURE 1. AC Test Circuit



Notes:
V_{CC}, V_{CCA} = +2V, V_{EE} = −2.5V
L1 and L2 = Equal length 50Ω impedance lines
R_T = 50Ω 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 = Fixture and stray capacitance ≤ 3 pF

FIGURE 2. Toggle Frequency Test Circuit

Switching Waveforms

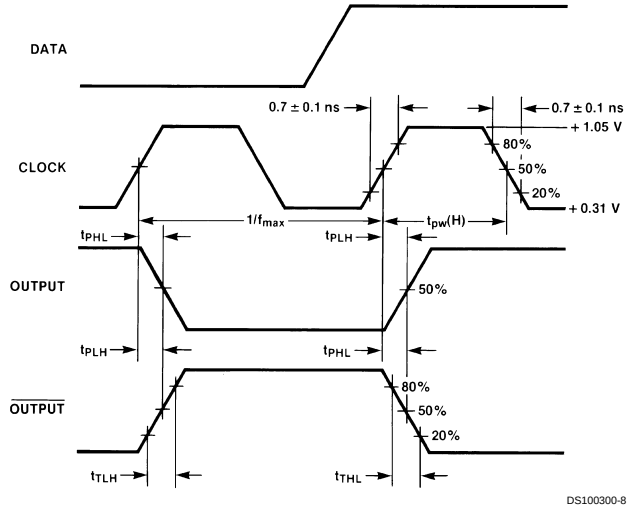


FIGURE 3. Propagation Delay (Clock) and Transition Times

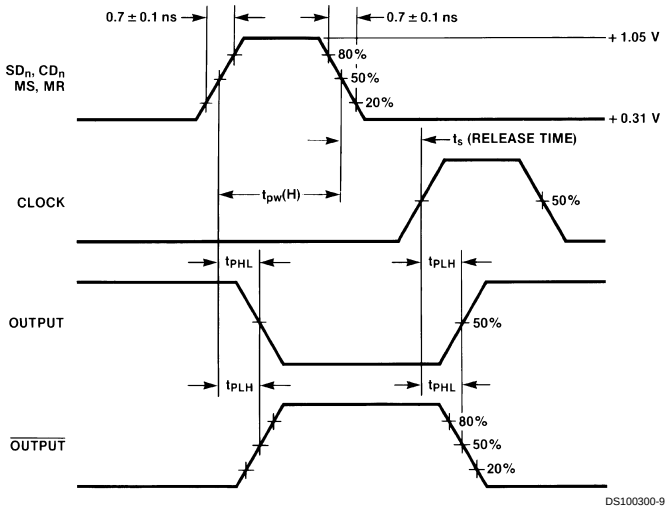


FIGURE 4. Propagation Delay (Resets)

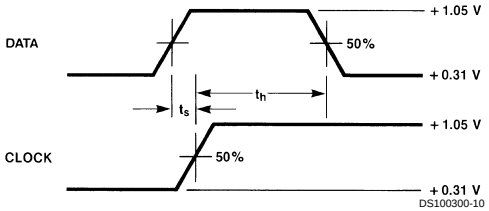
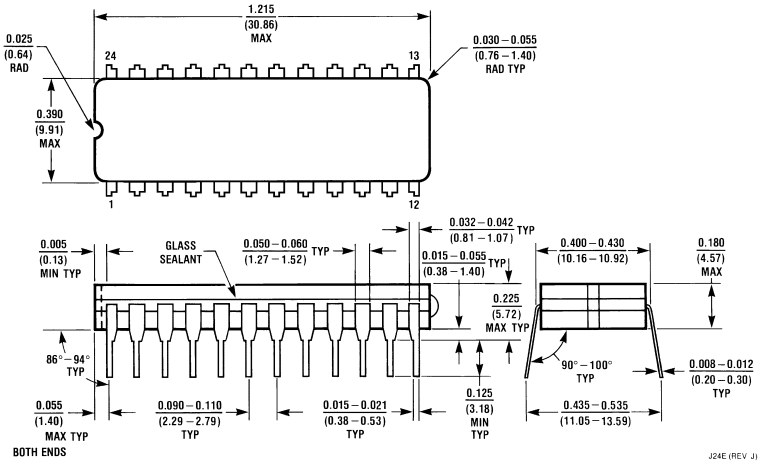


FIGURE 5. Data Setup and Hold Time

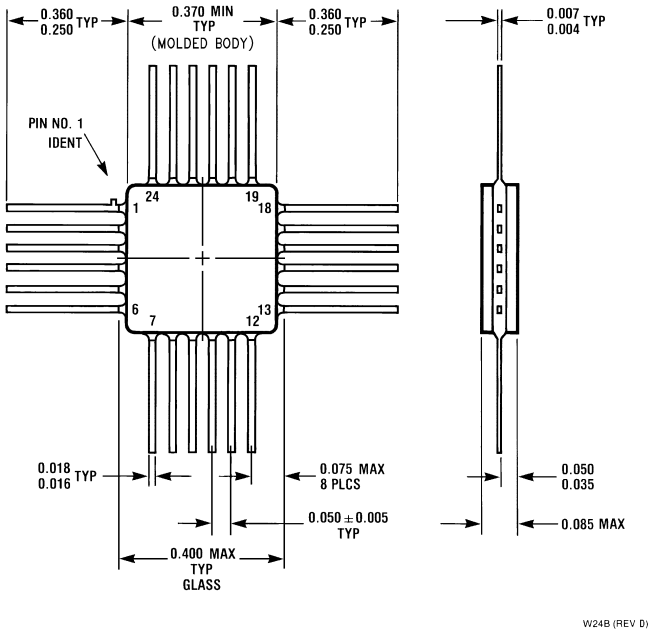
Note 11: t_S is the minimum time before the transition of the clock that information must be present at the data input.

Note 12: t_h is the minimum time after the transition of the clock that information must remain unchanged at the data input.

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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