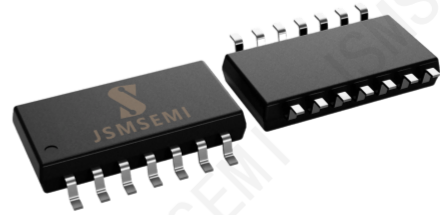


1、General Description

The HEF4013BT,653-JSM is a dual D-type flip-flop that features independent set-direct input (SD), clear-direct input (CD), clock input (CP) and outputs (Q, $\bar{Q}$). Data is accepted when CP is LOW and is transferred to the output on the positive-going edge of the clock. The active HIGH asynchronous CD and SD inputs are independent and override the D or CP inputs. The outputs are buffered for best system performance. The clock input's Schmitt-trigger action makes the circuit highly tolerant of slower clock rise and fall times. It operates over a recommended V_{DD} power supply range of 3V to 15V referenced to V_{SS} (usually ground). Unused inputs must be connected to V_{DD} , V_{SS} , or another input.

Features:

- Wide supply voltage range from 3V to 15V
- Fully static operation
- 5V, 10V, and 15V parametric ratings
- Standardized symmetrical output characteristics
- Tolerant of slow clock rise and fall times
- Specified from -40°C to $+125^{\circ}\text{C}$
- Packaging information: SOP14



2、Block Diagram And Pin Description

2.1、Block Diagram

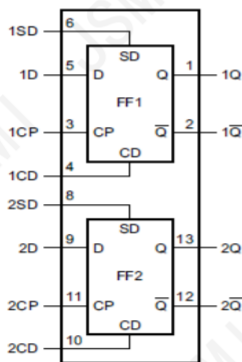


Figure 1. Functional diagram

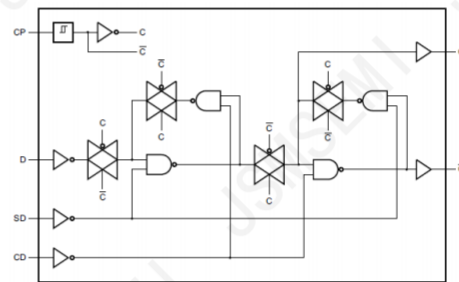
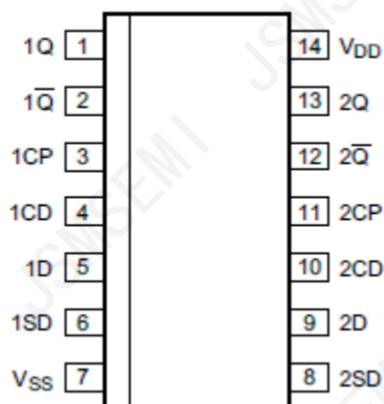


Figure 2. Logic diagram (one flip-flop)

Ordering Information

Order number	Package	Operation Temperature Range	MSL Grade	Ship,Quantity	Green
HEF4013BT,653-JSM	SOP-14	-40 to 125°C	3	T&R,2500	Rohs

2.2、Pin Configurations



2.3、Pin Description

Pin No.	Pin Name	Description
1	1Q	true output
2	1Q̄	complement output
3	1CP	clock input (LOW to HIGH edge-triggered)
4	1CD	asynchronous clear-direct input (active HIGH)
5	1D	data input
6	1SD	asynchronous set-direct input (active HIGH)
7	V _{ss}	ground (0V)
8	2SD	asynchronous set-direct input (active HIGH)
9	2D	data input
10	2CD	asynchronous clear-direct input (active HIGH)
11	2CP	clock input (LOW to HIGH edge-triggered)
12	2Q̄	complement output
13	2Q	true output
14	V _{DD}	supply voltage

2.4、Function Table

Input				Output	
nSD	nCD	nCP	nD	nQ	nQ̄
H	L	X	X	H	L
L	H	X	X	L	H
H	H	X	X	H	H
L	L	↑	L	L	H
L	L	↑	H	H	L

Note: H=HIGH voltage level; L=LOW voltage level; X=don't care; ↑=LOW-to-HIGH clock transition.

3、Electrical Parameter

3.1、Absolute Maximum Ratings

(Voltages are referenced to V_{SS} (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Max.	Unit
supply voltage	V_{DD}	-	-0.5	+18	V
DC input current	I_{IK}	any one input	-	± 10	mA
input voltage	V_I	all inputs	-0.5	$V_{DD}+0.5$	V
storage temperature	T_{stg}	-	-65	+150	°C
total power dissipation	P_{tot}	-	-	500	mW
device dissipation	P	per output transistor	-	100	mW
Soldering temperature	T_L	10s	260		°C

3.2、Recommended Operating Conditions

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
supply voltage	V_{DD}	-	3	-	15	V
ambient temperature	T_{amb}	in free air	-40	-	+125	°C
set-up time	t_{su}	$V_{DD}=5V$	40	-	-	ns
		$V_{DD}=10V$	20	-	-	ns
		$V_{DD}=15V$	15	-	-	ns
clock pulse width	t_{wCL}	$V_{DD}=5V$	140	-	-	ns
		$V_{DD}=10V$	60	-	-	ns
		$V_{DD}=15V$	40	-	-	ns
clock input frequency	f_{CL}	$V_{DD}=5V$	3.5	7	-	MHz
		$V_{DD}=10V$	8	16	-	MHz
		$V_{DD}=15V$	12	24	-	MHz
clock rise and fall time	t_{rCL}, t_{fCL}	$V_{DD}=5V$	-	-	15	us
		$V_{DD}=10V$	-	-	10	us
		$V_{DD}=15V$	-	-	5	us
Set or reset pulse width	$t_{ws/R}$	$V_{DD}=5V$	180	-	-	ns
		$V_{DD}=10V$	80	-	-	ns
		$V_{DD}=15V$	50	-	-	ns

Note: If more than one unit is cascaded in a parallel clocked operation, t_{rCL} must be made less than or equal to the sum of the fixed propagation delay time at 15pF and the transistion time of the output driving stage for the estimated capacitive load.

3.3、Electrical Characteristics

3.3.1、DC Characteristics 1

($T_{amb}=25^{\circ}\text{C}$, voltages are referenced to V_{SS} (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions (V)			$T_{amb}=25^{\circ}\text{C}$			Unit
		V_O	V_{IN}	V_{DD}	Min.	Typ.	Max.	
supply current	I_{DD}	-	0, 5	5	-	-	1	uA
		-	0, 10	10	-	-	2	uA
		-	0, 15	15	-	-	4	uA
LOW-level output current	I_{OL}	0.4	0, 5	5	0.51	1	-	mA
		0.5	0, 10	10	1.3	2.6	-	mA
		1.5	0, 15	15	3.4	6.8	-	mA
HIGH-level output current	I_{OH}	4.6	0, 5	5	-0.51	-1	-	mA
		2.5	0, 5	5	-1.6	-3.2	-	mA
		9.5	0, 10	10	-1.3	-2.6	-	mA
		13.5	0, 15	15	-3.4	-6.8	-	mA
LOW-level output voltage	V_{OL}	-	0, 5	5	-	0	0.05	V
		-	0, 10	10	-	0	0.05	V
		-	0, 15	15	-	0	0.05	V
HIGH-level output voltage	V_{OH}	-	0, 5	5	4.95	5	-	V
		-	0, 10	10	9.95	10	-	V
		-	0, 15	15	14.95	15	-	V
LOW-level input voltage	V_{IL}	0.5, 4.5	-	5	-	-	1.5	V
		1, 9	-	10	-	-	3	V
		1.5, 13.5	-	15	-	-	4	V
HIGH-level input voltage	V_{IH}	0.5, 4.5	-	5	3.5	-	-	V
		1, 9	-	10	7	-	-	V
		1.5, 13.5	-	15	11	-	-	V
input leakage current	I_I	-	0, 15	15	-	-	± 1	uA

3.3.2、DC Characteristics 2

($T_{amb} = -40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$, voltages are referenced to V_{SS} (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions (V)			$T_{amb} = -40^{\circ}\text{C}$		$T_{amb} = +85^{\circ}\text{C}$		$T_{amb} = +125^{\circ}\text{C}$		Unit
		V_O	V_{IN}	V_{DD}	Min.	Max.	Min.	Max.	Min.	Max.	
supply current	I_{DD}	-	0, 5	5	-	1	-	30	-	30	μA
		-	0, 10	10	-	2	-	60	-	60	μA
		-	0, 15	15	-	4	-	120	-	120	μA
LOW-level output current	I_{OL}	0.4	0, 5	5	0.61	-	0.42	-	0.36	-	mA
		0.5	0, 10	10	1.5	-	1.1	-	0.9	-	mA
		1.5	0, 15	15	4	-	2.8	-	2.4	-	mA
HIGH-level output current	I_{OH}	4.6	0, 5	5	-0.61	-	-0.42	-	-0.36	-	mA
		2.5	0, 5	5	-1.8	-	-1.3	-	-1.15	-	mA
		9.5	0, 10	10	-1.5	-	-1.1	-	-0.9	-	mA
		13.5	0, 15	15	-4	-	-2.8	-	-2.4	-	mA
LOW-level output voltage	V_{OL}	-	0, 5	5	-	0.05	-	0.05	-	0.05	V
		-	0, 10	10	-	0.05	-	0.05	-	0.05	V
		-	0, 15	15	-	0.05	-	0.05	-	0.05	V
HIGH-level output voltage	V_{OH}	-	0, 5	5	4.95	-	4.95	-	4.95	-	V
		-	0, 10	10	9.95	-	9.95	-	9.95	-	V
		-	0, 15	15	14.95	-	14.95	-	14.95	-	V
LOW-level input voltage	V_{IL}	0.5, 4.5	-	5	-	1.5	-	1.5	-	1.5	V
		1, 9	-	10	-	3	-	3	-	3	V
		1.5, 13.5	-	15	-	4	-	4	-	4	V
HIGH-level input voltage	V_{IH}	0.5, 4.5	-	5	3.5	-	3.5	-	3.5	-	V
		1, 9	-	10	7	-	7	-	7	-	V
		1.5, 13.5	-	15	11	-	11	-	11	-	V
input leakage current	I_I	-	0, 15	15	-	± 1	-	± 1	-	± 1	μA

3.3.3、AC Characteristics

($T_{amb}=25^{\circ}\text{C}$, $V_{SS}=0\text{V}$, $t_r, t_f=20\text{ns}$, $C_L=50\text{pF}$, $R_L=20\text{k}\Omega$, unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
HIGH to LOW propagation delay	t_{PHL}	nCP to nQ, $\bar{nQ}$; see Figure 4	$V_{DD}=5\text{V}$	-	150	300 ns
			$V_{DD}=10\text{V}$	-	65	130 ns
			$V_{DD}=15\text{V}$	-	45	90 ns
		nSD to $\bar{nQ}$ or nCD to nQ	$V_{DD}=5\text{V}$	-	200	400 ns
			$V_{DD}=10\text{V}$	-	85	170 ns
			$V_{DD}=15\text{V}$	-	60	120 ns
LOW to HIGH propagation delay	t_{PLH}	nCP to nQ, $\bar{nQ}$; see Figure 4	$V_{DD}=5\text{V}$	-	150	300 ns
			$V_{DD}=10\text{V}$	-	65	130 ns
			$V_{DD}=15\text{V}$	-	45	90 ns
		nSD to nQ or nCD to $\bar{nQ}$	$V_{DD}=5\text{V}$	-	150	300 ns
			$V_{DD}=10\text{V}$	-	65	130 ns
			$V_{DD}=15\text{V}$	-	45	90 ns
transition time	t_t	see Figure 4	$V_{DD}=5\text{V}$	-	100	200 ns
			$V_{DD}=10\text{V}$	-	50	100 ns
			$V_{DD}=15\text{V}$	-	40	80 ns
maximum clock frequency	$f_{clk(max)}$	see Figure 4	$V_{DD}=5\text{V}$	3.5	7	- MHz
			$V_{DD}=10\text{V}$	8	16	- MHz
			$V_{DD}=15\text{V}$	12	24	- MHz
pulse width	t_w	nCP input LOW; see Figure 4	$V_{DD}=5\text{V}$	-	70	140 ns
			$V_{DD}=10\text{V}$	-	30	60 ns
			$V_{DD}=15\text{V}$	-	20	40 ns
		nSD input HIGH or nCD input HIGH; see Figure 5	$V_{DD}=5\text{V}$	-	90	180 ns
			$V_{DD}=10\text{V}$	-	40	80 ns
			$V_{DD}=15\text{V}$	-	25	50 ns
set-up time	t_{su}	nD to nCP; see Figure 4	$V_{DD}=5\text{V}$	-	20	40 ns
			$V_{DD}=10\text{V}$	-	10	20 ns
			$V_{DD}=15\text{V}$	-	7	15 ns
hold time	t_h	nD to nCP; see Figure 4	$V_{DD}=5\text{V}$	-	2	5 ns
			$V_{DD}=10\text{V}$	-	2	5 ns
			$V_{DD}=15\text{V}$	-	2	5 ns
clock input rise or fall time	t_{rCL}, t_{fCL}	-	$V_{DD}=5\text{V}$	-	-	15 us
			$V_{DD}=10\text{V}$	-	-	10 us
			$V_{DD}=15\text{V}$	-	-	5 us
input capacitance	C_i	any input	-	5	7.5	pF

Note: t_t is the same as t_{TLH} and t_{THL} .

4、Testing Circuit

4.1、AC Testing Circuit

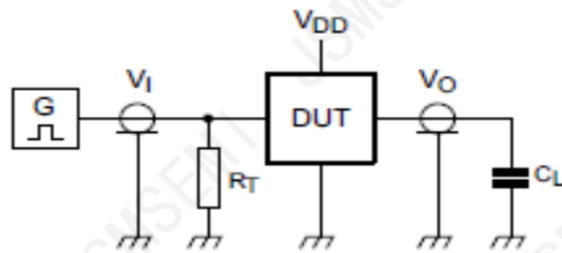


Figure 3. Test circuit for switching times

Definitions for test circuit:

DUT=Device Under Test.

C_L =Load capacitance including jig and probe capacitance.

R_T =Termination resistance should be equal to the output impedance Z_o of the pulse generator.

4.2、AC Testing Waveforms

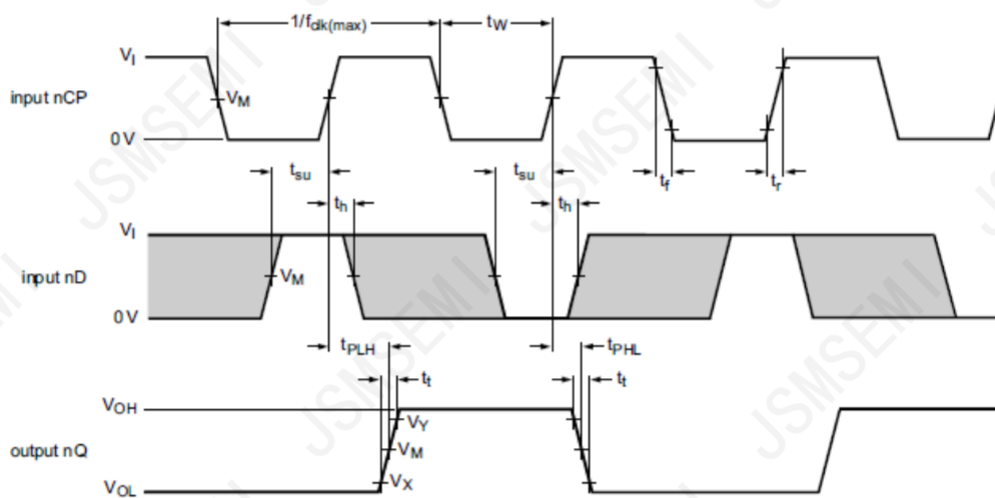


Figure 4. Set-up time, hold time, minimum clock pulse width, propagation delays and transition times

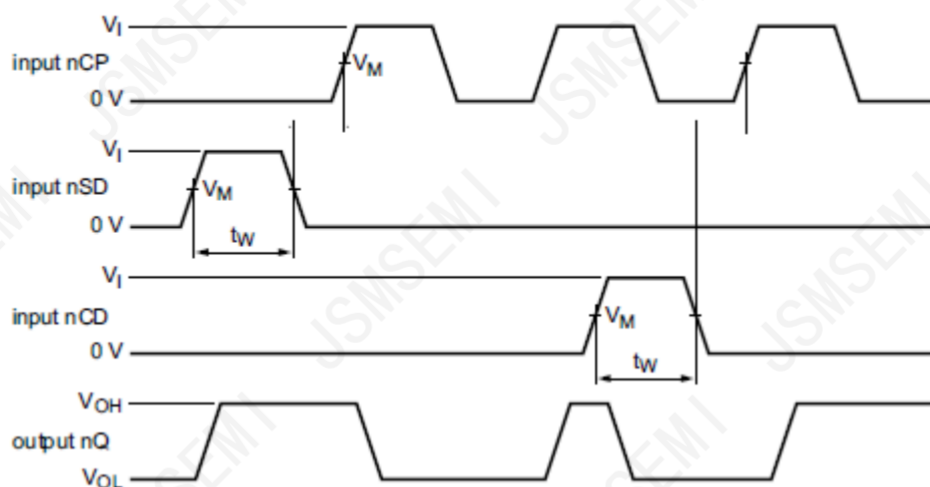


Figure 5. nSD, nCD pulse width

4.3、Measurement Points

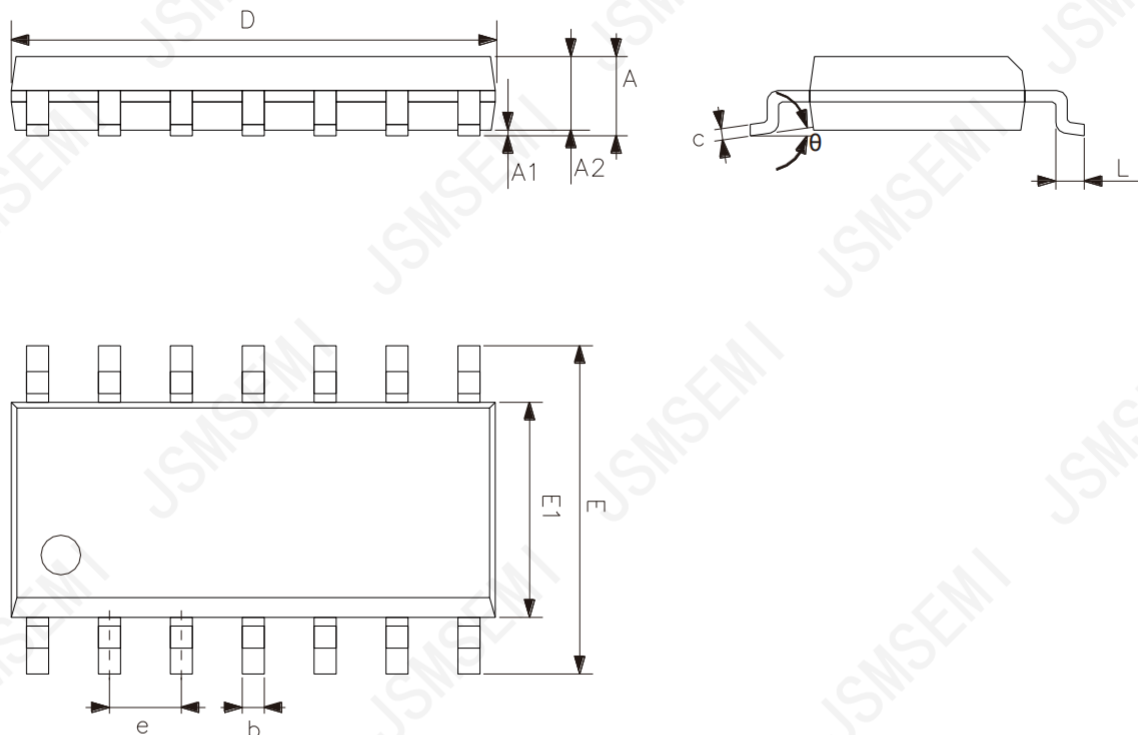
Supply voltage	Input	Output		
V_{DD}	V_M	V_M	V_X	V_Y
5V to 15V	$0.5 \times V_{DD}$	$0.5 \times V_{DD}$	$0.1 \times V_{DD}$	$0.9 \times V_{DD}$

4.4、Test Data

Supply voltage	Input		Load
V_{DD}	V_I	t_r, t_f	C_L
5V to 15V	V_{SS} or V_{DD}	$\leq 20\text{ns}$	50pF

5、Package Information

SOP14



Symbol	Dimensions (mm)	
	Min.	Max.
A	1.50	1.75
A1	0.05	0.25
A2	1.30	-
b	0.33	0.50
c	0.19	0.25
D	8.43	8.76
E	5.80	6.25
E1	3.75	4.00
e	1.27	
L	0.40	0.89
θ	0°	8°

6、Statements And Notes

6.1、The name and content of Hazardous substances or Elements in the product

Part name	Hazardous substances or Elements									
	Lead and lead compounds	Mercury and mercury compounds	Cadmium and cadmium compounds	Hexavalent chromium compounds	Polybrominated biphenyls	Polybrominated biphenyl ethers	Dibutyl phthalate	Butylbenzyl phthalate	Di-2-ethylhexyl phthalate	Diisobutyl phthalate
Lead frame	○	○	○	○	○	○	○	○	○	○
Plastic resin	○	○	○	○	○	○	○	○	○	○
Chip	○	○	○	○	○	○	○	○	○	○
The lead	○	○	○	○	○	○	○	○	○	○
Plastic sheet installed	○	○	○	○	○	○	○	○	○	○
explanation	○: Indicates that the content of hazardous substances or elements in the detection limit of the following the SJ/T11363-2006 standard. ×: Indicates that the content of hazardous substances or elements exceeding the SJ/T11363-2006 Standard limit requirements.									

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