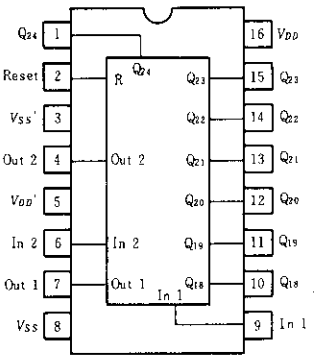
24-Stage Frequency Divider

The HD14521B consists of a chain of 24 flip-flops with an input circuit that allows three modes of operation. The input will function as a crystal oscillator, an RC oscillator, or as an input buffer for an external oscillator. Each flip-flop divides the frequency of the previous flip-flop by two, consequently this part will count up to 2^{24}=16,777,216. The outputs of the last seven-stages are available for added flexibility.

■ FEATURES

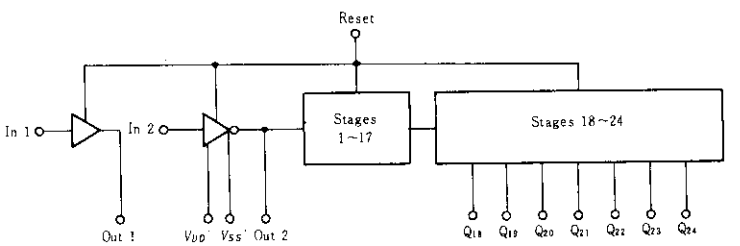
- Quiescent Current= 5nA/pkg typ. @5V f(max)=9MHz typ @10V
- All Stages are Resettable
- Reset Disables the RC Oscillator for Low Standby Power Drain
- RC and Crystal Oscillator Outputs are capable of Driving External Loads
- Test Mode to Reduce Test time
- VDD' and VSS' Pins Brought Out on Crystal Oscillator Inverter to Allow the Connection of External Resistors for Low-power Operation
- Supply Voltage Range=3 to 18V
- Capable of Driving One Low-power Schottky TTL Load Over the Rated Temperature Range

■ PIN ARRANGEMENT



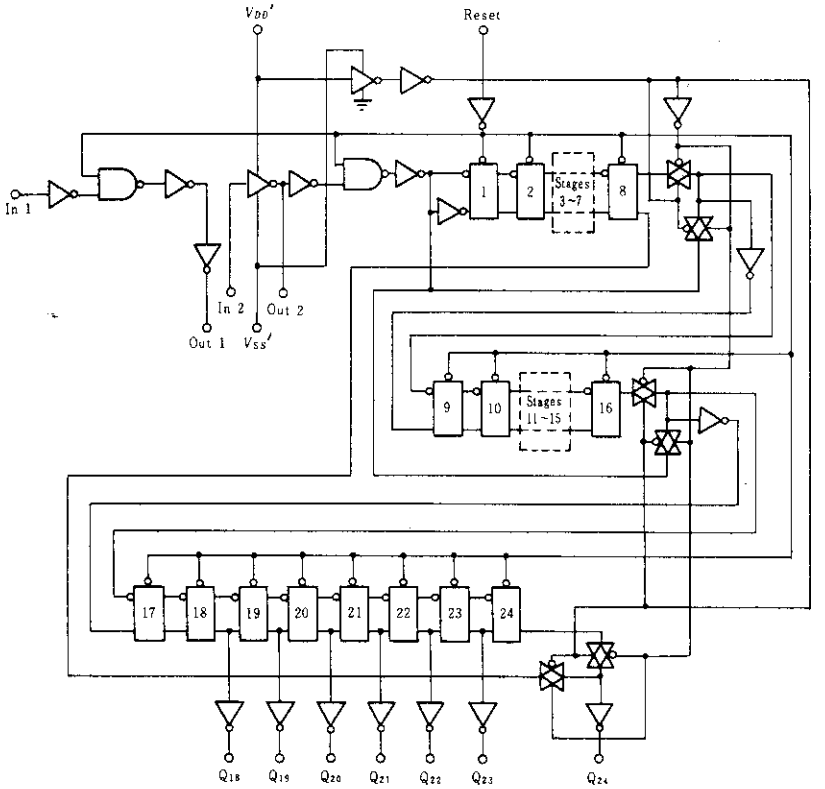
(Top View)

■ BLOCK DIAGRAM



Output	Count Capacity
Q_{18}	2^{18}=262,144
Q_{19}	2^{19}=524,288
Q_{20}	2^{20}=1,048,576
Q_{21}	2^{21}=2,097,152
Q_{22}	2^{22}=4,194,304
Q_{23}	2^{23}=8,388,608
Q_{24}	2^{24}=16,777,216

■LOGIC DIAGRAM

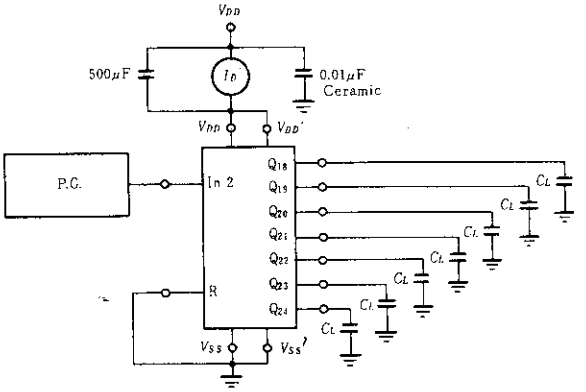


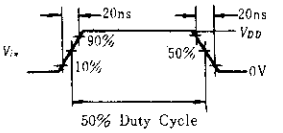
■ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	V_{DD}(V)	Test Conditions	−40℃ min	−40℃ max	25℃ min	25℃ typ	25℃ max	85℃ min	85℃ max	Unit
Output Voltage	V_{OL}	5.0	$V_{in}=V_{DD}$ or 0	—	0.05	—	0	0.05	—	0.05	V
		10		—	0.05	—	0	0.05	—	0.05	
		15		—	0.05	—	0	0.05	—	0.05	
	V_{OH}	5.0	$V_{in}=0$ or V_{DD}	4.95	—	4.95	5.0	—	4.95	—	V
		10		9.95	—	9.95	10	—	9.95	—	
		15		14.95	—	14.95	15	—	14.95	—	
Input Voltage	V_{IL}	5.0	$V_{out}=4.5$ or 0.5V	—	1.5	—	2.25	1.5	—	1.5	V
		10	$V_{out}=9.0$ or 1.0V	—	3.0	—	4.50	3.0	—	3.0	
		15	$V_{out}=13.5$ or 1.5V	—	4.0	—	6.75	4.0	—	4.0	
	V_{IH}	5.0	$V_{out}=0.5$ or 4.5V	3.5	—	3.5	2.75	—	3.5	—	V
		10	$V_{out}=1.0$ or 9.0V	7.0	—	7.0	5.50	—	7.0	—	
		15	$V_{out}=1.5$ or 13.5V	11.0	—	11.0	8.25	—	11.0	—	
Output Drive Current	I_{OH}	5.0	$V_{OH}=2.5$V	−1.0	—	−0.8	−1.7	—	−0.6	—	mA
		5.0	$V_{OH}=4.6$V	−0.2	—	−0.16	−0.36	—	−0.12	—	
		10	$V_{OH}=9.5$V	−0.5	—	−0.4	−0.9	—	−0.3	—	
		15	$V_{OH}=13.5$V	−1.4	—	−1.2	−3.5	—	−1.0	—	
	I_{OL}	5.0	$V_{OL}=0.4$V	0.52	—	0.44	0.88	—	0.36	—	mA
		10	$V_{OL}=0.5$V	1.3	—	1.1	2.25	—	0.9	—	
		15	$V_{OL}=1.5$V	3.6	—	3.0	8.8	—	2.4	—	
Input Current	I_{in}	15		—	±0.3	—	±0.00001	±0.3	—	±1.0	μA
Input Capacitance	C_{in}	—	$V_{in}=0$	—	—	—	5.0	7.5	—	—	pF
Quiescent Current	I_{DD}	5.0	Zero Signal, per Package	—	20	—	0.005	20	—	150	μA
		10		—	40	—	0.010	40	—	300	
		15		—	80	—	0.015	80	—	600	
Total Supply Current*	I_T	5.0	Dynamic+I_{DD}, per Gate $C_L=50$ pF, $f=1$ kHz	—	—	—	0.42	—	—	—	μA
		10		—	—	—	0.85	—	—	—	
		15		—	—	—	1.4	—	—	—	

* To calculate total supply current at frequency other than 1kHz,
@V_{DD}=5.0V $I_T=(0.42\mu A/kHz)f+I_{DD}$, @$V_{DD}$=10V $I_T=(0.85\mu A/kHz)f+I_{DD}$, @$V_{DD}$=15V $I_T=(1.4\mu A/kHz)f+I_{DD}$

■POWER DISSIPATION TEST CIRCUIT AND WAVEFORM

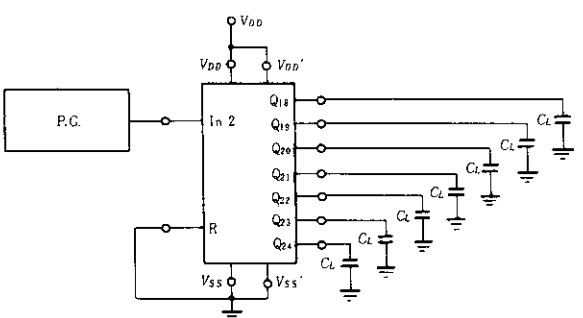


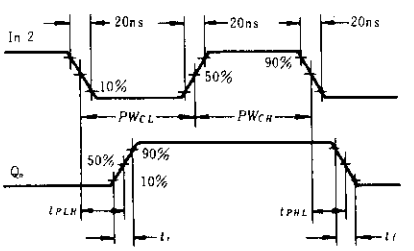


■SWITCHING CHARACTERISTICS (C_L=50pF, Ta=25°C)

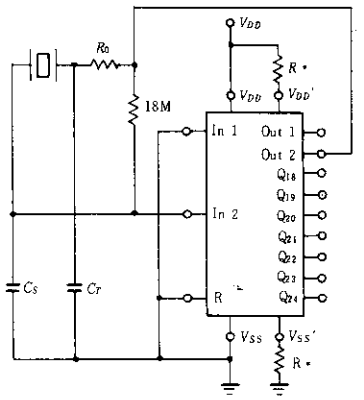
Characteristic		Symbol	V_{DD}(V)	min	typ	max	Unit
Output Rise Time		t_r	5.0	—	180	400	ns
			10	—	90	200	
			15	—	65	160	
Output Fall Time		t_f	5.0	—	120	250	ns
			10	—	60	125	
			15	—	40	100	
Propagation Delay Time	Clock to Q_{18}	t_{PLH}, t_{PHL}	5.0	—	4.5	13.5	μs
			10	—	1.7	5.2	
			15	—	1.2	3.9	
	Clock to Q_{24}		5.0	—	6.0	18	
			10	—	2.2	6.5	
			15	—	1.5	5.0	
	Reset to Q_n	t_{PHL}	5.0	—	1300	4000	ns
			10	—	500	1500	
			15	—	350	1200	
Clock Pulse Width		PW_C	5.0	385	140	—	ns
			10	150	55	—	
			15	120	40	—	
Clock Frequency		PRF	5.0	—	3.5	1.5	MHz
			10	—	9.0	3.5	
			15	—	12	4.5	
Clock Pulse Rise and Fall Time		t_r, t_f	5.0	—	—	15	μs
			10	—	—	15	
			15	—	—	15	
Reset Pulse Width		PW_R	5.0	1800	700	—	ns
			10	900	300	—	
			15	700	200	—	

■SWITCHING TIME TEST CIRCUIT





■ CRYSTAL OSCILLATOR CIRCUIT

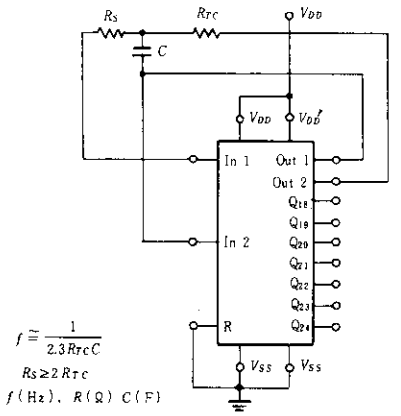


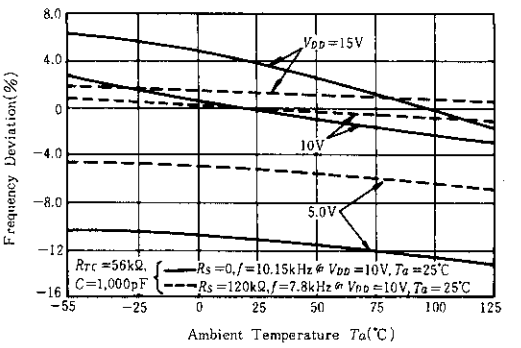
Optional for low power operation.

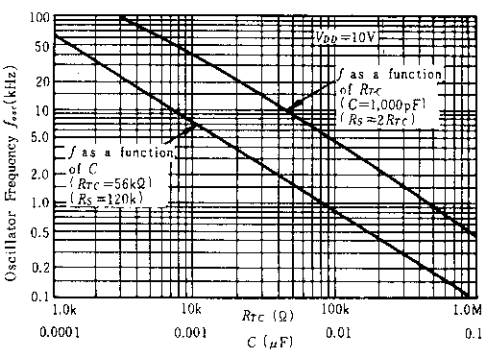
Characteristic			500kHz Circuit	500kHz Circuit	Unit
Crystal Characteristics		Resonant Frequency	500	50	kHz
		Cut	S	N	
		Equivalent Resistance, R_S	1.0	6.2	kΩ
External Resistor/ Capacitor Values		R_O	47	750	kΩ
		C_T	82	82	pF
		C_S	20	20	pF
Frequency Change as a Funetion of V_{DD}		V_{DD} Change from 5V to 10V	+6.0	+2.0	ppm
		V_{DD} Change from 10V to 15V	+2.0	+2.0	ppm
Frequency Change as a Function of Temperature (V_{DD}=10V)	−55~+25℃	HD14521B Only	−4.0	−2.0	ppm
		Complete Osc.*	+100	+120	ppm
	+25~+125℃	HD14521B Only	−2.0	−2.0	ppm
		Complete Osc.*	−160	−560	ppm

*Complete oscillator includes crystal, capacitors, and resistors.

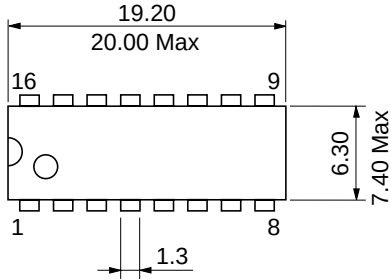
■ RC OSCILLATOR CIRCUIT

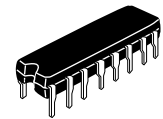


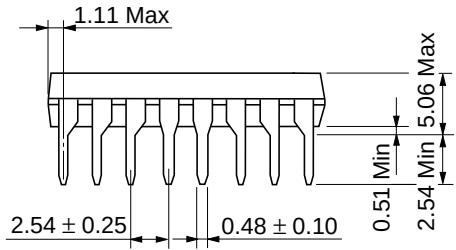


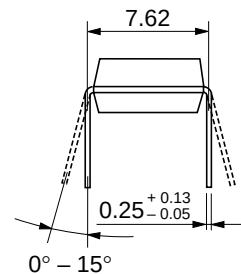


Unit: mm









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Weight (reference value)	1.07 g

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Hitachi, Ltd.
Semiconductor & Integrated Circuits.
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan
Tel: Tokyo (03) 3270-2111 Fax: (03) 3270-5109

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For further information write to:

Hitachi Semiconductor
(America) Inc.
179 East Tasman Drive,
San Jose,CA 95134
Tel: <1> (408) 433-1990
Fax: <1>(408) 433-0223

Hitachi Europe GmbH
Electronic components Group
Dornacher Straße 3
D-85622 Feldkirchen, Munich
Germany
Tel: <49> (89) 9 9180-0
Fax: <49> (89) 9 29 30 00

Hitachi Europe Ltd.
Electronic Components Group.
Whitebrook Park
Lower Cookham Road
Maidenhead
Berkshire SL6 8YA, United Kingdom
Tel: <44> (1628) 585000
Fax: <44> (1628) 778322

Hitachi Asia Pte. Ltd.
16 Collyer Quay #20-00
Hitachi Tower
Singapore 049318
Tel: 535-2100
Fax: 535-1533

Hitachi Asia Ltd.
Taipei Branch Office
3F, Hung Kuo Building. No.167,
Tun-Hwa North Road, Taipei (105)
Tel: <886> (2) 2718-3666
Fax: <886> (2) 2718-8180

Hitachi Asia (Hong Kong) Ltd.
Group III (Electronic Components)
7/F., North Tower, World Finance Centre,
Harbour City, Canton Road, Tsim Sha Tsui,
Kowloon, Hong Kong
Tel: <852> (2) 735 9218
Fax: <852> (2) 730 0281
Telex: 40815 HITEC HX