

# HD14046B

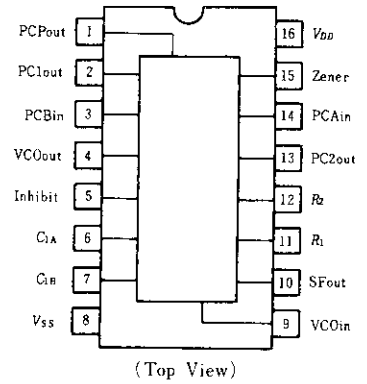
## Phase-Locked Loop

The HD14046B phase-locked loop contains two phase comparators, a voltage-controlled oscillator (VCO), source follower, and zener diode. The comparators have two common signal inputs, PCAin and PCBin. Input PCAin can be used directly coupled to large voltage signals, or indirectly coupled (with a series capacitor) to small voltage signals. The self-bias circuit adjusts small voltage signals in the linear region of the amplifier. Phase comparator 1 (an exclusive OR gate) provides a digital error signals PC1 out, and maintains 90° phase shift at the center frequency between PCAin and PCBin signals (both at 50% duty cycle). Phase comparator 2 (with leading edge sensing logic) provides digital error signals PC2out and PCPout, and maintains a 0° phase shift between PCAin and PCBin signals (duty cycle is immaterial). The linear VCO produces an output signal VCOout whose frequency is determined by the voltage of input VCOin and the capacitor and resistors connected to pins C1A, C1B, R1, and R2. The source-follower output SFout with an external resistor is used where the VCOin signal is needed but no loading can be tolerated. The inhibit input Inh, when high, disables the VCO and source follower to minimize standby power consumption. The zener diode can be used to assist in power supply regulation. Applications include FM and FSK modulation and demodulation, frequency synthesis and multiplication, frequency discrimination, tone decoding, data synchronization and conditioning, voltage-to-frequency conversion and motor speed control.

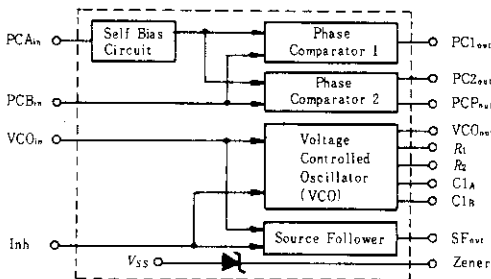
### FEATURES

- VCO Frequency = 1.4MHz typ. @10V
- VCO Frequency Drift with Temperature = 0.04%/°C typ. @10V
- VCO Linearity = 1% typ.
- Quiescent Current = 5nA/pkg @5V
- Low Dynamic Power Dissipation = 70μW typ. @f<sub>0</sub> = 10kHz,
- V<sub>DD</sub> = 5V, R<sub>1</sub> = 1MΩ, R<sub>2</sub> = ∞, R<sub>SF</sub> = ∞
- Diode Protection on All Inputs
- Supply Voltage Range = 3 to 18V
- Pin-for-Pin Replacement for CD4046B and MC14046B

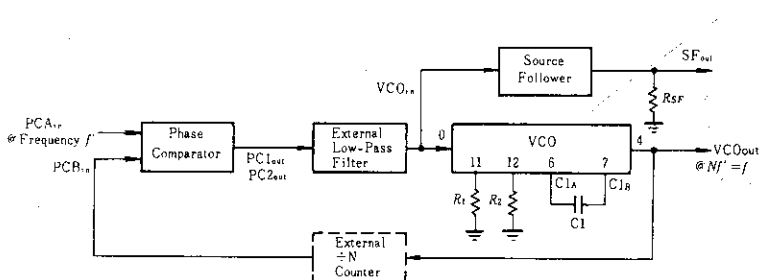
### PIN ARRANGEMENT



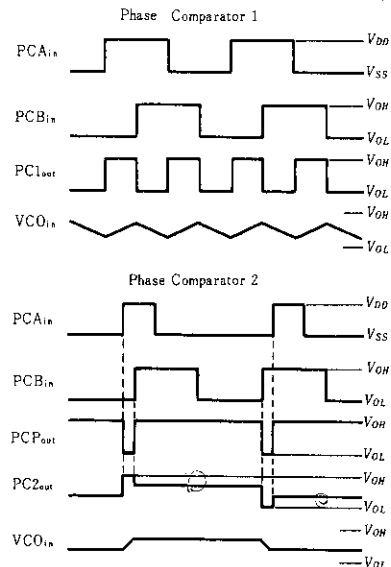
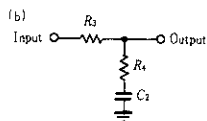
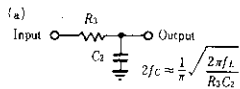
### BLOCK DIAGRAM



■ GENERAL PHASE-LOCKED LOOP CONNECTIONS AND WAVEFORMS



Typical Low-Pass Filters



■ ELECTRICAL CHARACTERISTICS—1

Characteristic	Symbol	Test Conditions	-40°C		25°C		85°C		Unit	
			min	max	min	typ	max	min		max
Output Voltage	VOL	5.0	—	0.05	—	0	0.05	—	0.05	V
		10	—	0.05	—	0	0.05	—	0.05	
		15	—	0.05	—	0	0.05	—	0.05	
	VOH	5.0	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	VIL	5.0	—	1.5	—	2.25	1.5	—	1.5	V
		10	—	3.0	—	4.50	3.0	—	3.0	
		15	—	4.0	—	6.75	4.0	—	4.0	
	VIH	5.0	3.5	—	3.5	2.75	—	3.5	—	V
		10	7.0	—	7.0	5.50	—	7.0	—	
		15	11.0	—	11.0	8.25	—	11.0	—	
Output Drive Current	IOH	5.0	-1.0	—	-0.8	-1.7	—	-0.6	—	mA
		5.0	-0.2	—	-0.16	-0.36	—	-0.12	—	
		10	-0.5	—	-0.4	-0.9	—	-0.3	—	
	IOL	5.0	0.52	—	0.44	0.88	—	0.36	—	mA
		10	1.3	—	1.1	2.25	—	0.9	—	
		15	3.6	—	3.0	8.8	—	2.4	—	
Input Current	Iin	15	—	±0.3	—	±0.0001	±0.3	—	±1.0	μA
Input Capacitance	Cin	—	—	—	5.0	7.5	—	—	pF	
Quiescent Current	IDD	5.0	—	20	—	0.005	20	—	150	μA
		10	—	40	—	0.010	40	—	300	
		15	—	80	—	0.015	80	—	600	
Total Supply Current*	IT	5.0	—	—	—	1.46	—	—	—	μA
		10	—	—	—	2.91	—	—	—	
		15	—	—	—	4.37	—	—	—	

\* To calculate total supply current at frequency other than 1kHz.

@VDD = 5.0V IT = (1.46 μA/kHz)f + IDD, @VDD = 10V IT = (2.91 μA/kHz)f + IDD, @VDD = 15V IT = (4.37 μA/kHz)f + IDD

## ELECTRICAL CHARACTERISTICS—2 ( $C_L = 50\text{ pF}$ , $T_a = 25^\circ\text{C}$ )

Characteristic	Symbol	$V_{DD}$ (V)	Test Conditions	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		—	100	200	ns
		10		—	50	100	
		15		—	37	80	

### PHASE COMPARATORS 1 and 2

Characteristic	Symbol	$V_{DD}$ (V)	Test Conditions	min	typ	max	Unit
Input Resistance	PCBin	5.0		1.0	2.0	—	M $\Omega$
		10		0.2	0.4	—	
		15		0.1	0.2	—	
	PCBin	15		15	1500	—	
Minimum Input Sensitivity	$\cdot V_{in}$	5.0	AC Coupled—PCBin,	—	200	400	mV <sub>p-p</sub>
		10	C Series=1000pF,	—	400	800	
		15	$f = 50\text{ kHz}$	—	700	1400	
DC Coupled-PCBin,PCBin		5~15		See Noise Immunity			

### VOLTAGE CONTROLLED OSCILLATOR(VCO)

Characteristic	Symbol	$V_{DD}$ (V)	Test Conditions	min	typ	max	Unit
Maximum Frequency	$f_{max}$	5.0	$V_{COin} = V_{DD}$ , $C_1 = 50\text{ pF}$ , $R_1 = 5\text{ k}\Omega$ , $R_2 = \infty$	0.35	0.70	—	MHz
		10		0.7	1.4	—	
		15		1.0	1.9	—	
Temperature-Frequency Stability		5.0	$R_2 = \infty$	—	0.12	—	%/ $^\circ\text{C}$
		10		—	0.04	—	
		15		—	0.015	—	
Linearity		5.0	$V_{COin} = 2.50\text{ V} \pm 0.30\text{ V}$ , $R_1 \geq 10\text{ k}\Omega$	—	1	—	%
		10	$V_{COin} = 5.00\text{ V} \pm 2.50\text{ V}$ , $R_1 \geq 400\text{ k}\Omega$	—	1	—	
		15	$V_{COin} = 7.50\text{ V} \pm 5.00\text{ V}$ , $R_1 \geq 1000\text{ k}\Omega$	—	1	—	
Output Duty Cycle		5~15		—	50	—	%
Input Resistance (VCOin)	$R_{in}$	15		15	1500	—	M $\Omega$

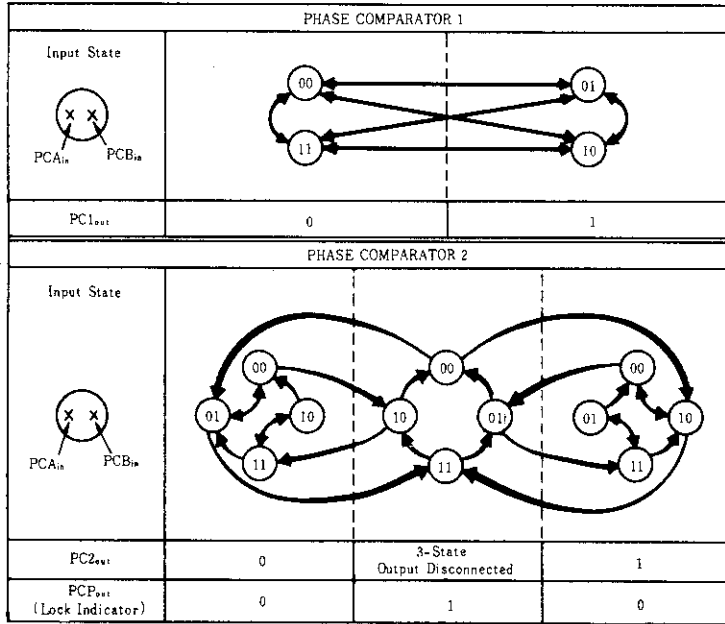
### SOURCE-FOLLOWER

Characteristic	Symbol	$V_{DD}$ (V)	Test Conditions	min	typ	max	Unit
Offset Voltage		5.0	$V_{COin} = SF_{out}$ , $R_{SF} > 50\text{ k}\Omega$	—	1.65	2.5	V
		10		—	1.65	2.5	
		15		—	1.65	2.5	
Linearity		5.0	$V_{COin} = 2.50\text{ V} \pm 0.30\text{ V}$ , $R_{SF} > 50\text{ k}\Omega$	—	0.1	—	%
		10	$V_{COin} = 5.00\text{ V} \pm 2.50\text{ V}$ , $R_{SF} > 50\text{ k}\Omega$	—	0.6	—	
		15	$V_{COin} = 7.50\text{ V} \pm 5.00\text{ V}$ , $R_{SF} > 50\text{ k}\Omega$	—	0.8	—	

### ZENER DIODE

Characteristic	Symbol	$V_{DD}$ (V)	Test Conditions	min	typ	max	Unit
Zener Voltage	$V_Z$		$I_Z = 50\text{ }\mu\text{A}$	6.3	7.0	7.7	V
Dynamic Resistance	$R_Z$		$I_Z = 1\text{ mA}$	—	100	—	$\Omega$

■ PHASE COMPARATORS STATE DIAGRAMS





Hitachi Code	DP-16
JEDEC	Conforms
EIAJ	Conforms
Weight (reference value)	1.07 g

## Cautions

1. Hitachi neither warrants nor grants licenses of any rights of Hitachi's or any third party's patent, copyright, trademark, or other intellectual property rights for information contained in this document. Hitachi bears no responsibility for problems that may arise with third party's rights, including intellectual property rights, in connection with use of the information contained in this document.
2. Products and product specifications may be subject to change without notice. Confirm that you have received the latest product standards or specifications before final design, purchase or use.
3. Hitachi makes every attempt to ensure that its products are of high quality and reliability. However, contact Hitachi's sales office before using the product in an application that demands especially high quality and reliability or where its failure or malfunction may directly threaten human life or cause risk of bodily injury, such as aerospace, aeronautics, nuclear power, combustion control, transportation, traffic, safety equipment or medical equipment for life support.
4. Design your application so that the product is used within the ranges guaranteed by Hitachi particularly for maximum rating, operating supply voltage range, heat radiation characteristics, installation conditions and other characteristics. Hitachi bears no responsibility for failure or damage when used beyond the guaranteed ranges. Even within the guaranteed ranges, consider normally foreseeable failure rates or failure modes in semiconductor devices and employ systemic measures such as fail-safes, so that the equipment incorporating Hitachi product does not cause bodily injury, fire or other consequential damage due to operation of the Hitachi product.
5. This product is not designed to be radiation resistant.
6. No one is permitted to reproduce or duplicate, in any form, the whole or part of this document without written approval from Hitachi.
7. Contact Hitachi's sales office for any questions regarding this document or Hitachi semiconductor products.

# HITACHI

## 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

URL      North America      : <http://semiconductor.hitachi.com/>  
             Europe                 : <http://www.hitachi-eu.com/hel/ecg>  
             Asia (Singapore)        : <http://www.has.hitachi.com.sg/grp3/sicd/index.htm>  
             Asia (Taiwan)             : [http://www.hitachi.com.tw/E/Product/SICD\\_Frame.htm](http://www.hitachi.com.tw/E/Product/SICD_Frame.htm)  
             Asia (HongKong)         : <http://www.hitachi.com.hk/eng/bo/grp3/index.htm>  
             Japan                        : <http://www.hitachi.co.jp/Sicd/indx.htm>

## 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

Copyright ' Hitachi, Ltd., 1999. All rights reserved. Printed in Japan.

**HITACHI**