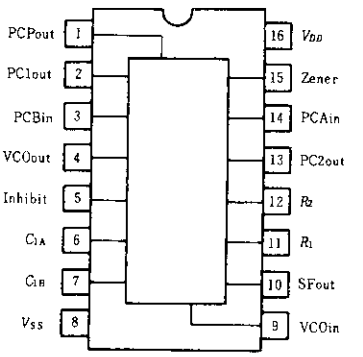
HD14046B

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 $C1_A$, $C1_B$, 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 docoding, data synchronization and conditioning, voltage-to-frequency conversion and motor speed control.

■ PIN ARRANGEMENT

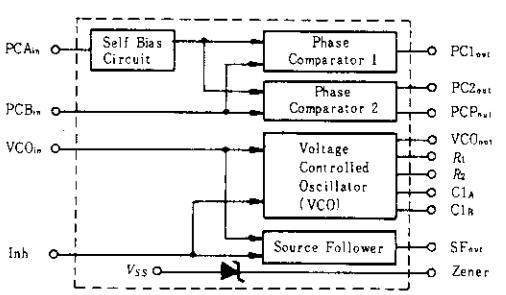


(Top View)

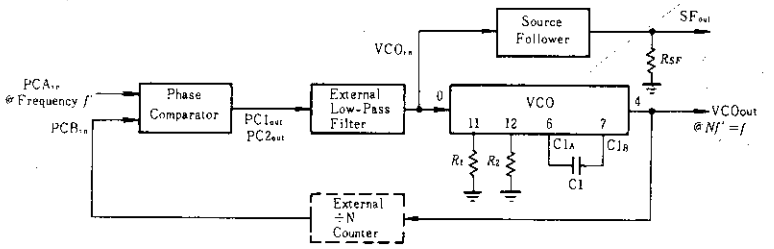
■ FEATURES

- 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_0 = 10kHz,
- V_{DD} = 5V, R1 = 1MΩ, R2 = ∞, R_{SF} = ∞
- Diode Protection on All Inputs
- Supply Voltage Range = 3 to 18V
- Pin-for-Pin Replacement for CD4046B and MC14046B

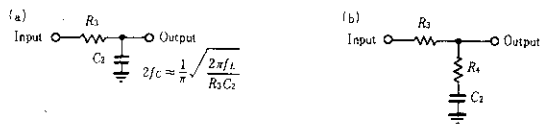
■ BLOCK DIAGRAM

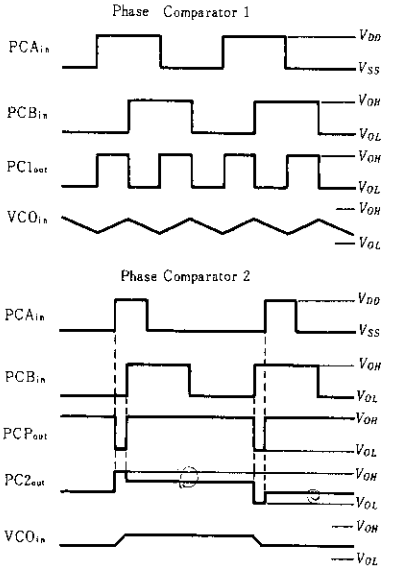


■GENERAL PHASE-LOCKED LOOP CONNECTIONS AND WAVEFORMS



Typical Low-Pass Filters





■ELECTRICAL CHARACTERISTICS—1

Characteristic	Symbol	V_{DD}(V)	Test Conditions	−40°C min	−40°C max	25°C min	25°C typ	25°C max	85°C min	85°C 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,	—	20	—	0.005	20	—	150	μA
		10	per Package	—	40	—	0.010	40	—	300	
		15	$I_{nh}=1$, PCA=1	—	80	—	0.015	80	—	600	
Total Supply Current*	I_T	5.0	$I_{nh}=0$, $f_o=10$kHz,	—	—	—	1.46	—	—	—	μA
		10	$C_L=50$pF, $R_1=1$MΩ,	—	—	—	2.91	—	—	—	
		15	$R_2=\infty$, $R_{SF}=\infty$, 50% Duty Cycle, $f=1$kHz	—	—	—	4.37	—	—	—	

* To calculate total supply current at frequency other than 1kHz.
@$V_{DD}=5.0$V $I_T=(1.46\,\mu A/kHz)f+I_{DD}$, @$V_{DD}=10$V $I_T=(2.91\,\mu A/kHz)f+I_{DD}$, @$V_{DD}=15$V $I_T=(4.37\,\mu A/kHz)f+I_{DD}$

■ ELECTRICAL CHARACTERISTICS — 2 ($C_L = 50\,pF$, $Ta = 25°C$)

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	PCAin	R_{in}	5.0		1.0	2.0	—	MΩ
			10		0.2	0.4	—	
			15		0.1	0.2	—	
	PCBin		15		15	1500	—	
Minimum Input Sensitivity		$*V_{in}$	5.0	AC Coupled—PCAin,	—	200	400	mV_{P-P}
			10	C Series = 1000pF,	—	400	800	
			15	$f = 50\,kHz$	—	700	1400	
DC Coupled-PCAin, 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	$VCO_{in} = V_{DD}$, $C_1 = 50\,pF$, $R_1 = 5\,k\Omega$, $R_2 = \infty$		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	—	%/°C
		10			—	0.04	—	
		15			—	0.015	—	
Linearity		5.0	$R_2 = \infty$	$VCO_{in} = 2.50\,V \pm 0.30\,V$, $R_1 \geqq 10\,k\Omega$	—	1	—	%
		10		$VCO_{in} = 5.00\,V \pm 2.50\,V$, $R_1 \geqq 400\,k\Omega$	—	1	—	
		15		$VCO_{in} = 7.50\,V \pm 5.00\,V$, $R_1 \geqq 1000\,k\Omega$	—	1	—	
Output Duty Cycle		5~15			—	50	—	%
Input Resistance (VCOin)	R_{in}	15			15	1500	—	MΩ

● SOURCE-FOLLOWER

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

● ZENER DIODE

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

■PHASE COMPARATORS STATE DIAGRAMS

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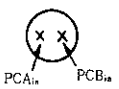
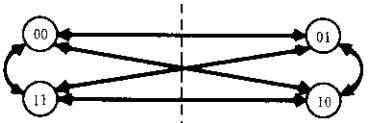
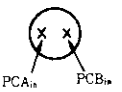
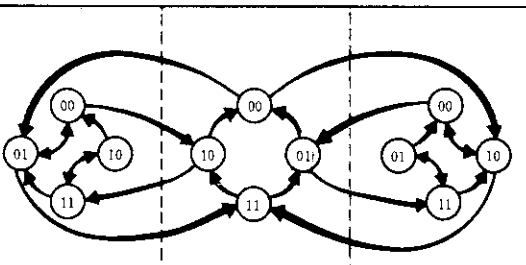
<tr><td>Input State
 
</td><td colspan="3"> 
</td></tr>
<tr><td>PC1$_{out}$</td><td>0</td><td colspan="2">1</td></tr>
<tr><td colspan="4">PHASE COMPARATOR 2</td></tr>
<tr><td>Input State
 
</td><td colspan="3"> 
</td></tr>
<tr><td>PC2$_{out}$</td><td>0</td><td>3-State
Output Disconnected</td><td>1</td></tr>
<tr><td>PCP$_{out}$
(Lock Indicator)</td><td>0</td><td>1</td><td>0</td></tr>
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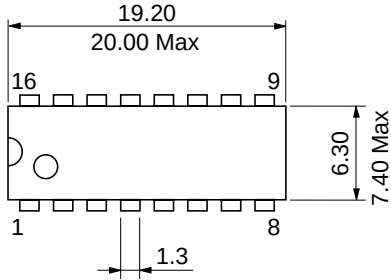
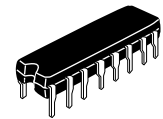
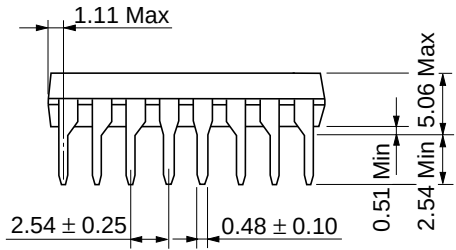
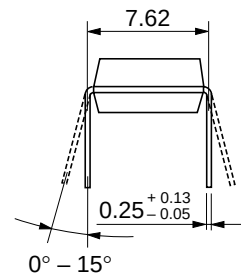
Unit: mm









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

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